IV. RESULTS AND DISCUSSIONS

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Two experiments were involved as previously mentioned in this study. The first was dealing with the influence of some foliar spray treatments i.e. two N sources, zinc sulphate and gibberellin either solely or combined each to other on growth and nutritional status of Picual and Manzanillo rooted cuttings olive cvs. "experiment,I". While the second was carried out to ivestigate the response to both application methods of N,P fertilizers, as well as some combinations and rate of soil applied N,P,K fertilizers "experiment II"

Thus obtained data concerning the effect of different treatments used in both experiments "I and II" either on vegetative growth or mineral composition of Picual and Manzanillo rooted cuttings will be exposed separately into the following two topics:

IV. 1. Vegetative growth:

Concerning vegetative growth parameters of Picual and Manzanillo rooted cuttings as affected by the different treatments used of both "I and II" experiments conducted during the three seasons of 1987, 1988 and 1989, obtained data are presented in Tables (3,4,5,6,7,8,9,10,11,12,13 and 14).

IV. 1.1. Stem length :

IV. 1.1.a. Experiment, I :-

Regarding the effect of the different foliar spray treatments with solutions of two N sources "urea and ammonium sulphate each at 1%", zinc sulphate at 500 ppm and gibberellin at 100 ppm either solely or in combination on stem length of both Picual and Manzanillo rooted cuttings during 1987, 1988 and 1989 seasons, data are presented in Table (3). It is quite evident that all the different foliar spray solutions resulted in a highly significant increament in stem length of those rooted cuttings received any of the eight solutions used as compared with the water sprayed ones "control" during the three seasons of study, regardless of olive cultivar.

Moreover, as the foliar spray solutions of 1% urea and 1% ammonium sulphate were compared as two N sources, obtained results revealed that urea was more effective in 1987 season, while the reverse was true during both 1988 and 1989 seasons, for the Picual rooted cuttings. The differences were significant during the first and last seasons, but it was so small to reach the significance level in the second one. However, urea 1% sprayed rooted cuttings of Manzanillo Cv. showed statistically longer stem than those received ammonium sulphate 1% during 1988 and 1989 seasons, but in 1987 season the two N solutions were statistically of the same

influence. In addition, it could be noticed that the response of Picual cv. to ammonium sulphate was more pronounced than urea as an average of stem length during the three seasons of study was concerned, while the reverse was true with Manzanillo cv.

Foliar sprays either with zinc sulphate at 500 ppm or gibberellin 100 ppm significantly increased stem length in rooted cuttings of both olive cvs. during the three seasons of study. However,GA treatment significantly exceeded Zn SO_4 in this concern with Picual cv. during three seasons of study. Besides, the same trend was detected with Manzanillo during the 1987 season only, but in 1988 and 1989 seasons both treatments showed a comparable effect.

Referring to the foliar spray with the different combined solutions used i.e.urea 1% combined either with Zn SO_4 500 ppm or GA 100 ppm, as well as ammonium sulphate 1% combined with Zn SO_4 or GA, obtained data declared that as GA was mixed either with urea or ammonium sulphate a drastic effect on stem length of both olive cvs. was detected. Since, foliar spray either with urea + GA or $(NH_4)_2SO_4$ + GA solutions produced the tallest stem. This trend was generally detected as the (urea + GA) and (ammonium sulphate + GA) sprayed nursery plants of both olive cultivars from one side were compared with those of the corresponding cv. which received any of (urea, GA or $(NH_4)_2SO_4$ solutions alone) from the other. However, few exceptions could be

Table (3): Stem length in response to foliar spray with 2 N sources, Zn and gibberellin in rooted cuttings of Picual and Manzanillo olive cvs. during the three successive 1987 , 1988 and 1989 seasons.

Spray treatments	Length in cms.							
	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "water spray"	34.7	24.2	33.5	30.8	33.6	30.8	28.0	30.8
2. Urea 1 %	53.3	27.0	38.1	39.5	40.7	41.8	46.0	42.8
3. Ammonium sulphate 1 %	47.3	29.0	47.0	41.1	41.3	31.3	37.8	36.8
4. Zinc sulphate 500 ppm	47.8	31.2	38.8	39.3	41.9	41.5	36.0	39.8
5. Gibberellin 100 ppm	52.2	34.3	44.7	43.7	50.4	40.5	34.2	41.7
6. Urea 1% + Zn SO_4 500 ppm	43.0	27.8	32.5	34.4	41.3	37.3	45.0	41.2
7. Urea 1% + Gibberellin 100 ppm	60.3	34.2	47.3	47.3	53.0	41.3	52.2	48.8
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	40.5	30.0	38.3	36.3	34.8	37.3	47.8	40.0
9. $(NH_4)_2$ SO_4 1%+gibberellin 100 ppm	65.6	32.3	46.0	47.9	42.8	47.7	46.5	45.7
L.S.D. . . . . at 5 % level	2.34	2.02	1.54	——	0.80	2.20	1.90	——
. . . . . at 1 % level	3.15	2.72	2.07	——	1.03	3.00	2.20	——

noticed when the (ammonium sulphate + GA) sprayed plants were compared with GA sprayed ones of Manzanillo and Picual cvs. during 1987 and 1988 seasons, respectively. On the other hand, spraying Zn SO_4 combined either with urea or $(NH_4)_2SO_4$ showed a retarding effect on stem length as compared with urea, ammonium sulphate and zinc sulphate solutions when each was applied individually except in 1989 season with Manzanillo cv.

Generally, it could be concluded that foliar spray with gibberellin combined either with urea or ammonium sulphate were the superior treatments as the stem length of rooted cuttings was concerned, regardless of olive cultivar.

These results are in general agreement with the findings of Milella and Deidda,(1975), Ferreira et al., (1980) and Sharaf et al.,(1984) concerning the effect of N foliar applications on shoot growth of olive seedlings grown in pots, 6-year-old olive trees and one-year-old seedlings of sour orange, Cleopatra mandarin and rough lemon, respectively. In addition, the present results concerning the effect of zinc are in harmony with that previously mentioned by Sharaf et al.,(1984) and Sharaf and Khamis,(1984) on some Citrus rootstock seedlings. Moreover, the result obtained on the influence of GA foliar sprays goes in line with that reported by Bartolini and Ministro, (1981) and Abo-Taleb, (1987) on nursery olive plants.

IV. 1.1.b. Experiment, II :

Reffering to stem length as affected by rate and application method of N,P,K fertilizers data are presented in Table (4). It is quite evident that N foliar application "1% $(NH_4)_2SO_4$" treatment increased stem length of rooted cuttings over those of check treatment during three seasons of study for both Picual and Manzanillo olive cvs. This icrease was highly significant, except with Manzanillo cv. in 1988 season, where the difference in stem length of 1% $(NH_4)_2SO_4$ sprayed rooted cuttings than control was so small to reach the level of significance.

Nevertheless, the N soil application at the lower rate "2.0 gm actual N per plant" i.e. the N_1 treatment showed approximately the same stem length value of control. Although, the stem tended to be longer than control, but such increase is negligible except in 1989 season where the difference was highly significant with both olive cultivars. Moreover, the N soil application at the higher level "4.0 gm N/plant" i.e. the N_2 soil application treatment showed a depressive effect in stem length of both Picual and Manzanillo rooted cuttings. Such decrease was highly significant except in the 1987 season, since variation was negligible with both olive cvs.

With respect to the effect of P soil application either at lower or higher rates (2.0-4.0 gm. P_2O_5/ plant) Table (4)

shows that both treatments resulted in a highly significant increase in stem length of both cultivars over control, except with Picual rooted cuttings in 1989 season. Besides, Manzanillo cv. showed a relatively higher response to both P_2O_5 levels. In addition, the higher P_2O_5 level (P_2 treatment) was more effective than P_1 treatment as an vaerage of the three seasons was concerned with both two olive cvs.

As for potassium soil application obtained data revealed that both levels (K_1 & K_2 treatments) statistically enhanced stem elongation over the control during three seasons of study, regardless of olive cultivar. However, the higher K level (K_2 treatment) significantly exceeded the lower rate (K_1) for Picual cv., the trend took the other way around with Manzanillo cv. during the three seasons of study. Moreover, the response to potassium fertilizer was more pronounced with Manzanillo than Picual cvs. Since, as an average of the three seasons was concerned, the increament % over control varied from 36.4 - 51.3 and from 16.2 - 24.0 % in both Manzanillo and Picual cvs., respectively.

As for the (N_2 + P_2) soil application treatment (adding 4.0 gm. actual N + 4.0 gm. P_2O_5 in the form of ammonium sulphate and superphosphate, respectively), obtained data revealed that rooted cuttings of both cultivars received such treatment statistically exceeded not only control but also those received N_2 only. In other words, adding superphosphate to the higher N fertilizer rate (N_2 level) sig-

Table (4): Variation in stem length of Picual and Manzanillo rooted cuttings in relation to level, application method and some combinations of N, P, K fertilizers during three successive 1987,1988 and 1989 seasons.

Treatments	Length in cms.							
	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "no fertilizer application"	34.7	24.2	33.5	30.8	33.6	30.8	28.0	30.8
2. N foliar applic. "1% $(NH_4)_2 SO_4$"	47.3	29.0	47.0	41.1	41.3	31.3	37.8	36.8
3. N_1 soil applic. "2 gm. N/plant"	32.3	25.8	40.5	32.9	34.3	31.2	48.0	37.8
4. N_2 soil applic. "4 gm. N/plant"	34.8	15.8	23.3	24.6	31.4	22.7	23.2	25.8
5. P_1 soil applic. "2 gm. P_2O_5/plant"	40.9	27.8	26.5	31.7	36.8	40.7	49.1	42.2
6. P_2 soil applic. "4 gm. P_2O_5/plant"	37.3	32.7	32.2	34.1	46.2	42.3	44.2	44.2
7. K_1 soil applic. "2 gm. K_2O/plant"	42.3	28.8	36.3	35.8	51.5	45.7	42.5	46.6
8. K_2 soil applic. "4 gm. K_2O/plant"	43.6	32.0	39.0	38.2	43.6	42.7	39.7	42.0
9. (N_2+P_2) soil applic."N, P_2O_5 each at 4.0 gm.	37.3	21.8	36.3	31.8	37.3	37.9	30.8	35.3
10.(N_2+K_2) soil applic."N, K_2O each at 4.0 gm.	27.3	17.0	24.0	22.8	31.6	23.2	47.0	33.9
11.(N_2+P_2+K_2) soil applic."N, P_2O_5, K_2O"each at 4 gm	42.2	21.8	25.8	30.0	36.7	23.1	32.2	30.7
12. P foliar application 0.5% orthophosphoric acid.	—	—	37.3	—	—	—	44.0	—
L.S.D. . . . . at 5 % level	1.99	1.90	1.94	—	2.35	3.48	1.67	—
. . . . . at 1 % level	2.71	2.60	2.64	—	3.20	4.75	2.28	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N, P, K fertilizers used, except the 12th. treatment, since orthophosphoric acid at 0.5% conc. was used.

nificantly eliminated the stunting effect of (N_2) level when it was applied solely.

Concerning effect of soil fertilization with (N_2+K_2) treatment, it is obvious that the Picual rooted cuttings produced significantly shorter stem as compared with those of control during the three seasons of study. Such trend was also occurred with Manzanillo rooted cuttings during 1987 and 1988 seasons only, while in 1989 season an opposite trend was detected. As well as, **Table (4)** shows that soil application of ($N_2+P_2+K_2$) treatment had no specific response on rooted cuttings stem length either as seasons of study or olive cultivars were concerned. Nevertheless, a significant increase was observed in 1987 season for both olive cvs., as well as in the 1989 season also for Manzanillo cv. only. Besides, the reverse was true for the others.

However, the P foliar application treatment (0.5% orthophosphoric acid) was investigated during the 1989 season only, data obtained showed a promising response. Since, the stem length increament gained in P foliar sprayed rooted cuttings was highly significant as compared either with control or those of both P_1 and P_2 soil application treatments in Picual cv. Meanwhile, with Manzanillo cv. the difference was significant in comparison to control only, but P foliar spray treatment was so effective as much as the P_2 soil application.

Concerning the exceeded effect of N foliar spray treat-

ment over soil application either at 2.0 or 4.0 gm. levels, it could be explained on the fact that adding $(NH_4)_2SO_4$ to soil increases the osmotic pressure of water and damages the new developed roots of such young plants which are still succulent and more susceptible. Accordingly this will be reflected negatively on growth of the nursery olive plants, especially those received the higher rate of N soil application. Besides, data of P application are in general agreement with the findings of **Farid,(1979)** and **Tattini** et al.,(1986). However, obtained data regarding potassium treatments go in line with that reported by **EL-Deeb,(1982)** and **Youssef** et al.,(1985) on seedlings of some Citrus rootstocks. In addition, inhibition in stem elongation of (N_2 + K_2) applied plants may be due to the toxic effect of N_2 rate only as previously mentioned or to the additional effect that could be occurred as the K_2SO_4 fertilizer which is readily soluble was also added. The partial elimination of the N_2 effect resulted when phosphorus was combined may be due the stimulation effect of the latter on developing new roots that could be replaced the damaged ones.

IV. 1.2. Stem dry weight :

IV. 1.2.a. Experiment I :

Referring to the effect of two N sources, Zn, gibberellin and their combinations on the stem dry weight of Picual

and Manzanillo rooted cuttings during 1987, 1988 and 1989 seasons data are presented in Table (5).

Data obtained disclosed that olive nursery plants of both cultivars realized a significant increase in their stem dry weight over the control as they were sprayed with 1% urea solution. Such increase was highly significant, except in 1988 season for Picual cv., where the difference was significant at the level of 5% only.

Foliar spray with 1% ammonium sulphate resulted in increasing the stem dry weight for both olive cultivars. However, the difference in Picual rooted cuttings was significant at 1 and 5 % levels during 1987, 1988 seasons, respectively, but it was negligible during the third season. In addition, with Manzanillo cv. the increase was highly significant during both 1987 and 1989 seasons, but in 1988 season it was insignificant.

Regarding the influence of both zinc sulphate at 500 ppm and gibberellin at 100 ppm as each solution was sprayed solely, data in Table (5) declared that an obvious increase was gained in the stem dry weight when compared with control, except in 1987 season when Manzanillo nursery plants were sprayed with $ZnSO_4$ 500 ppm. Differences were highly significant during three seasons with Picual cv., as well as during the second and third seasons only for Manzanillo olive cv. Moreover, the GA foliar spray treatment was more effective than the $ZnSO_4$ sprays either data of each season

Table (5): Stem dry weight in response to foliar spray with 2 N sources, Zn and gibberellin in rooted cuttings of Picual and Manzanillo olive cvs. during the three successive 1987 , 1988 and 1989 seasons.

spray treatments	Dry matter in gm.							
	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "water spray"	6.7	3.0	2.3	4.0	7.1	4.1	1.4	4.2
2. Urea 1 %	14.7	3.7	2.8	7.1	7.9	5.4	2.9	5.4
3. Ammonium sulphate 1 %	12.3	3.8	2.5	6.2	9.8	4.4	2.6	5.6
4. Zinc sulphate 500 ppm	10.9	4.6	2.7	6.1	6.7	6.4	1.9	5.0
5. Gibberellin 100 ppm	13.2	4.2	3.1	6.8	10.4	6.9	2.0	6.4
6. Urea 1% + Zn SO_4 500 ppm	13.7	3.8	2.6	6.7	8.4	5.9	2.2	5.5
7. Urea 1% + Gibberellin 100 ppm	15.6	3.3	3.1	7.3	11.3	6.3	3.0	6.9
8. $(NH_4)_2 SO_4$ 1% + Zn SO_4 500 ppm	12.4	3.5	2.4	6.1	7.5	4.8	1.9	4.7
9. $(NH_4)_2 SO_4$ 1% + gibberellin 100 ppm	18.9	4.3	3.0	8.7	9.6	7.5	3.1	6.7
L.S.D. . . . . at 5 % level	1.45	0.66	0.35	——	0.56	0.83	0.35	——
. . . . . at 1 % level	2.00	0.89	0.47	——	0.75	1.11	0.47	——

were compared solely or an average of the three seasons was concerned. The difference was highly significant in the 1987 season for both olive cvs., but during both 1988 and 1989 seasons the values of both treatments were to some extent the same except in 1989 where GA treatment was superior with Picual cv.

Concerning effect of foliar spray treatments with the different combinations used between urea, $(NH_4)_2SO_4$, Zn SO_4 and GA, data obtained revealed that an obvious increase in stem dry weight was occurred when the nursery plants of both olive cultivars were sprayed with the combined zinc sulphate with any of both N sources i.e. "Urea + Zn SO_4 or $(NH_4)_2$ SO_4 + Zn SO_4" treatments. However, such increase was highly significant as compared with control from one side, but significance was absent when compared both combinations of zinc sulphate each with that treatment contained only the corresponding N source from the other side.

Nevertheless, as the effect of both GA combinations with the two N sources was concerned, it is quite evident that both (Urea 1% + GA 100 ppm) and $(NH_4)_2$ SO_4 1% + GA 100 ppm) treatments resulted in a highly significant increase in stem dry weight over control on one hand, as well as over any of urea, ammonium sulphate or gibberellin when each was sprayed solely as an individual treatment in most cases, regardless of cultivar. In other words, both (Urea+GA) and (ammonium sulphate+GA) treatments were the superior regard-

ing the response of stem dry weight, where they surpassed all the other used treatments in this respect. This trend was true either data of each season or an average of the three seasons of study were concerned. Although, the combination of gibberellin with ammonium sulphate seemed to be more effective than with urea in most cases, especially, for Picual cultivar, in this respect.

The obtained results are supported by those previously mentioned by **Ferreira et al.,(1980) and Abo-Taleb, (1987).** On olive plants when sprayed either with urea or ammonium nitrate, respectively. Besideds, **Sharaf and Khamis, (1984)** suggested the same concerning Zn SO_4 foliar spray. Moreover, the beneficial effect of GA foliar spray either solely or combined with N was pointed out by **Abo-Taleb, (1987).**

IV. 1.2.b. Experiment, II :

Concerning stem dry weight of both Picual and Manzanillo nursery olive plants as influenced by level, application method and some combinations of N,P,K fertilizers data obtained during 1987, 1988 and 1989 seasons are presented in Table (6). It is easy to notice that N foliar application with a solution of 1% ammonium sulphate resulted in a highly significant increase over the control during three seasons of study for both olive cultivars. Moreover, soil application of ammonium sulphate at the lower rate (N_1 level) showed an increase over the control. Such increase

was so small to reach a significant level for Picual cv., while with Manzanillo it was more pronounced and significant especially during 1987 and 1989 seasons. As for the N_2 soil application (4.0 gm. actual N per plant), obtained data revealed that the applied plants showed a general decrease in their stem dry weight than the control. This trend was true during both 1988 and 1989 seasons, where the decrease was highly significant. While in 1987 season both N_2 and control treatments showed statistically the same values for both olive cvs.

Regarding soil application of superphosphate either at 2.0 or 4.0 gm. P_2O_5 per plant, obtained results declared that both treatments induced heavier stem dry matter over control. Besides, both treatments of P_1 and P_2 soil application showed nearly the same effect for both olive cvs. except in 1987 season where the lower level (P_1) statistically exceeded P_2 treatment with Picual cv., but the reverse was true with Manzanillo cv.

Data in Table (6) show that nursery plants of both Picual and Manzanillo olive cultivars were responded positively to both treatments of potassium soil application (2.0 or 4.0 gm. K_2O per plant) as their stem dry weight was compared with that of check treatment. However, this increase was highly significant in most cases, but during 1988 season the differences due to both the lower rate of potassium application (K_1) treatment for Picual cv. and the higher level

(K_2) in Manzanillo cv. were absent or significant at 5% level only as compared with the untreated plants for both Picual and Manzanillo cvs., respectively.

Referring to the response to the different combinations of N,P,K feritlizers used as soil application, Table (6) shows that (N_2 + P_2) treatment induced an obvious increase in stem dry weight over control. However, such increase was highly significant for Picual during 1987 and 1988 seasons, but during 1989 season the difference was negligible. Meanwhile, with Manzanillo cv. the increase due to (N_2 + P_2) treatment was so small to reach the level of significance in 1987, while it was significant at 5% and 1% as compared to control during 1988 and 1989 seasons, respectively. On the other hand, (N_2 + P_2) treatment to some extent was more effective with Picual than Manzanillo cv. Moreover, treatments of both (N_2 + K_2) and (N_2 + P_2 + K_2) combinations resulted in an inhibition in stem dry weight of nursery olive plants which received any of both treatments. The depressive effect of (N_2 + K_2) treatment was more pronounced, since it induced highly significant decrease during both 1987 and 1988 seasons as compared to control, regardless of olive cvs. While the (N_2 + P_2 + K_2) treatment showed a variable trends during three seasons of study as compared to control, but to some extent it showed nearly the same value of the stem dry weight of control as an average of three seasons was concerned.

Besides, the P foliar application (spraying with 0.5%

Table (6): Variation in stem dry weight of Picual and Manzanillo rooted cuttings in relation to level, application method and some combinations of N, P, K fertilizers during three successive 1987, 1988 and 1989 seasons.

Treatments *	Length in cms.							
	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "no fertilizer application"	6.7	3.0	2.3	4.0	7.1	4.1	1.4	4.2
2. N foliar applic. "1% $(NH_4)_2 SO_4$"	12.3	3.6	3.6	6.5	9.8	4.9	2.6	5.8
3. N_1 soil applic. "2 gm. N/plant"	7.3	3.0	2.5	4.3	8.9	3.7	2.6	5.1
4. N_2 soil applic. "4 gm. N/plant"	7.5	1.7	1.4	3.5	7.6	2.1	1.6	3.8
5. P_1 soil applic. "2 gm. P_2O_5/ plant"	14.4	4.1	2.4	7.0	6.1	6.8	2.7	5.2
6. P_2 soil applic. "4 gm. P_2O_5/ plant"	8.9	4.3	2.8	5.3	9.2	6.4	2.7	6.0
7. K_1 soil applic. "2 gm. K_2O / plant"	12.6	3.0	3.5	6.4	9.2	8.7	2.4	6.8
8. K_2 soil applic. "4 gm. K_2O / plant"	11.9	4.1	3.4	6.5	8.7	6.2	2.5	5.8
9. (N_2+P_2) soil applic. "N, P_2O_5 each at 4.0 gm."	11.4	4.2	2.4	6.0	8.5	4.9	2.7	5.4
10. (N_2+K_2) soil applic. "N, K_2O each at 4.0 gm."	5.3	1.8	1.9	3.0	6.0	2.1	2.2	3.4
11. $(N_2+P_2+K_2)$ soil applic. "N, P_2O_5, K_2O each at 4 gm	8.2	2.1	1.3	3.9	8.1	2.6	1.7	4.1
12. P foliar application 0.5% orthophosphoruc acid.			2.0				1.8	
L.S.D. . . . . at 5 % level	1.40	0.20	0.68		1.55	0.66	0.47	
. . . . . at 1 % level	1.90	0.30	0.92		2.11	0.90	0.64	

* Ammonium sulphate, superphosphate and potassium sulphate were the N, P, K fertilizers used, except the 12th. treatment, since orthophosphoric acid at 0.5% conc. was used.

orthophosphoric acid) did not statistically differ than control treatment as the response of stem dry weight was concerned.

The present results concerning the benificial effect of both N foliar application and soil application at the lower rate (2.0 gm. actual N/plant) are in agreement with that reported by Milella and Deidda,(1975), Sharaf et al., (1984) and Abo-Taleb,(1987). However, the retardation effect of the higher N rate was previously mentioned by Abu-Rumh,(1969) and Abo-Taleb,(1987). In addition, the increase in stem dry weight of the rooted cuttings received either superphosphate or potassium sulphate solely was coincided with that reported by Farid,(1979) and Tattini et al.,(1986) on phosphous fertilization, as well as EL-Deeb,(1982) and Youssef et al.,(1985) on potassium application.

Meanwhile, the drastic effect of superphosphate in increasing the stem dry weight when combined with $(NH_4)_2SO_4$ is in agreement with that reported by Tattini et al.,(1986). While the harmfull effect of K_2SO_4 when applied together with the ammonium sulphate may by due to the increase in osmotic pressure which resulted from adding both fertilizers together each at the higher rate.

IV. 1.3. Leaves dry weight :

IV. 1.3.a. Experiment,I :

Obtained data in **Table (7)** showed that urea 1 % sprayed nursery plants of both Picual and Manzanillo olive cvs. gained a highly significant increase in their leaves dry weight over control, except for Manzanillo cv. during 1988 where the increase was not significant. Moreover, the rooted cuttings of both Picual and Manzanillo olive cvs. were positively responded to the ammonium sulphate 1 % spray treatment when compared with the check treatment during three seasons of study. Such increase was highly significant, during three seasons of study with both olive cultivars. Generally, it could be noticed that urea 1% spray surpassed ammonium sulphate 1% treatment as an average of the three seasons was concerned in this respect. However, such trend was true during both 1987 and 1989 seasons for both cvs., but in 1988 season the trend took the other way around or the response to both treatments was nearly the same for Picual and Manzanillo cvs., respectively.

Meanwhile, sprayed rooted cuttings of Picual cv. either with Zn SO_4 at 500 ppm or gibberellin at 100 ppm induced highly significant increase in their leaves dry weight over the control during three seasons. On the other hand, the same trend was noticed with Manzanillo cv., but the increase due to both Zn SO_4 and GA spray treatments was not

Table (7): Leaves dry weight in response to foliar spray with 2 N sources, Zn and Gibberellin in rooted cuttings of Picual and Manzanillo olive cvs. during the three successive 1987 , 1988 and 1989 seasons.

Spray treatments	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "water spray"	10.8	4.9	2.3	6.0	9.9	6.8	1.9	6.2
2. Urea 1 %	18.3	6.2	3.7	9.4	15.1	7.2	3.3	8.5
3. Ammonium sulphate 1 %	16.6	7.0	2.7	8.8	11.5	7.8	2.8	7.4
4. Zinc sulphate 500 ppm	15.8	7.8	3.0	8.9	9.8	8.7	2.3	6.9
5. Gibberellin 100 ppm	15.3	5.6	2.7	7.9	10.4	7.1	2.4	6.6
6. Urea 1% + $ZnSO_4$ 500 ppm	19.4	5.7	2.7	9.3	12.1	8.1	2.6	7.6
7. Urea 1% + Gibberellin 100 ppm	18.1	5.7	3.2	9.0	14.0	7.5	3.1	8.2
8. $(NH_4)_2SO_4$ 1% + $ZnSO_4$ 500 ppm	17.7	6.0	3.0	8.9	10.4	8.1	2.2	6.9
9. $(NH_4)_2SO_4$ 1% + gibberellin 100 ppm	17.6	6.4	2.8	8.9	10.0	7.8	2.8	6.9
L.S.D. . . . . at 5 % level	1.38	0.39	0.39	—	0.73	0.68	0.30	—
. . . . . at 1 % level	1.90	0.53	0.53	—	0.98	0.92	0.41	—

pronounced as much as previously mentioned with Picual. In addition, both treatments induced statistically the same value of leaves dry weight in 1987 and 1989 seasons, but Zn SO_4 500 ppm treatment significantly exceeded the GA 100 ppm treatment during 1988 season for both cultivars.

As for both urea combinations, i.e. urea 1% combined either with 500 ppm Zn SO_4 or 100 ppm GA Table (7) shows obviously that both teatments significantly increased the leaves dry weight in rooted cuttings of both olive cultivars during three seasons of study. On the other hand, however, urea + GA treatment surpassed urea + Zn SO_4 in case of Manzanillo rooted cuttings, especially during 1987 and 1989 seasons, but for Picual no definite trend could be noticed. In addition, sprayed nursery plants of both olive cvs. either with (ammonium sulphate + Zn SO_4) or (ammonium sulphate + GA) treatments showed a highly significant increase in their leaves dry weight over control, except in 1987 season, where the increase in Manzanillo rooted cuttings was so small to be significant. However, the aforesaid both treatments showed a comparable values of leaves dry weight as they were compared each to other from one side, but they ranked second when compared with both treatments of urea combinations from the other.

Data obtained concerning the response of leaves dry weight to the different foliar spray treatments used in experiment,(I) could be discussed by the aforesaid explana-

tion with both length and dry weight of stem. However, no logic explanation could be offered as a suitable discussion for the unparallelled response of the obove ground organs i.e. stem parameters from one side and leaves dry weight from the other to gibberellin 100 ppm treatment, where leaves showed less response. Accordingly, further researchs are needed in this concern.

IV. 1.3.b. Experiment, II :

With respect to the effect of the different treatments used in experiment, II i.e. method of application, rate and some combinations of N,P,K fertilizers on leaves dry weight of olive nursery plants, data are presented in **Table (8)**. It is quite evident that nursery olive plants sprayed with 1% $(NH_4)_2 SO_4$ solution gained an obvious increase in their leaves dry weight over control. This increase was highly significant during three seasons of study with both olive cultivars. However, the difference showed that Picual was more responded to $(NH_4)_2 SO_4$ foliar spray at 1 % concentration than Manzanillo rooted cuttings.

In addition, N soil application at the N_1 level (2.0gm. actual N/plant) generally increased the leaves dry weight of the applied nursery olive plants of both Picual and Manzanillo cvs. as compared with control during all seasons of study. Although, differences were highly significant in plants of Manzanillo cv. during three seasons of study, but

with Picual it was significant at 5 % level during 1988 season only. Soil application of $(NH_4)_2SO_4$ at the rate of 4.0 gm. N per plant (N_2 treatment) decreased significantly the leaves dry weight of both Picual and Manzanillo rooted cuttings when compared with those received (N_1 treatment) of the corresponding cultivar during the three seasons of study. Moreover, the leaves dry weight of N_2 applied plants in both olive cvs. tended to be depressed as compared with control. However, the decrease was significant during 1988 season only, while both (N_2) and control treatments showed statistically the same values of leaves dry weight during both 1987 and 1989 seasons.

In other words, it could be noticed that, ammonium sulphate when applied either as foliar sprays of solution at 1% concentration or added to soil at the rate of 2.0 gm N per plant showed the same effect with Manzanillo olive, while with Picual the foliar application was more effective as the effect on leaves dry weight was concerned.

Regarding the soil application of superphosphate either at 2.0 or 4.0 gm. P_2O_5/plant (P_1 and P_2 treatments) obtained data showed that, both treatments induced a pronounced increase in leaves dry weight over control during three seasons for both cultivars. This increase was highly significant with few exceptions i.e., during 1987 for P_1 applied Manzanillo rooted cuttings and in 1989 season as P_1 and P_2 treated Picual plants were compared with control. On

the other hand no definite trend could be achieved as both levels of P soil application were compared. Since, during 1987 season two opposite trends were noticed as the responses to both P_1 and P_2 treatments were compared for each olive cultivar individually. Even though the P_1 applied Picual plants exceeded statistically those received P_2 treatment during 1987, but the trend took the other way around during 1988 season. In addition, as both levels of P soil application (P_1 and P_2 treatments) were compared concerning their effect on leaves dry weight of applied nursery olive plants, they showed similar effect during 1988 and 1989 seasons for Manzanillo and both olive cvs., respectively.

Nevertheless, potassium soil application either at 2.0 or 4.0 gm. K_2O per plant in the form of K_2SO_4 (K_1 and K_2 treatments), generally increased the leaves dry weight of both olive cultivars as compared with control during three seasons. Such increase was highly significant with both cultivars during 1987 and 1989 seasons. While in 1988 season the same level of significance was noticed also either with K_2 applied Picual plants or Manzanillo rooted cuttings received the K_1 treatment only, however the increase due to the other K level in plants of each cultivar was insignificant. Generally, it could be noticed that potassium soil application at the lower rate (K_1) was more effective as an average of three seasons was concerned.

Table (8):Variation in leaves dry weight of Picual and Manzanillo rooted cuttings in relation to level,application method and some combinations of N,P,K fertilizers during three successive 1987, 1988 and 1989 seasons.

Treatments *	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "no fertilizer application"	10.8	4.9	2.3	6.0	9.9	6.8	1.9	6.2
2. N foliar applic." 1% $(NH_4)_2 SO_4$ "	16.6	6.9	4.0	9.2	11.5	8.2	3.1	7.7
3. N_1 soil applic. "2 gm. N /plant "	11.6	5.8	2.7	6.7	11.5	8.0	3.5	7.7
4. N_2 soil applic. "4 gm. N/ plant "	10.6	2.9	2.0	5.2	10.1	4.8	2.4	5.8
5. P_1 soil applic. "2 gm. P_2O_5 / plant"	17.8	6.6	2.7	9.0	9.5	8.3	3.6	7.1
6. P_2 soil applic. "4 gm. P_2O_5 / plant"	12.2	7.9	2.7	7.6	12.4	8.6	3.3	8.1
7. K_1 soil applic. "2 gm. K_2O / plant"	16.3	5.5	3.3	8.4	12.2	10.4	3.5	8.7
8. K_2 soil applic. "4 gm. K_2O / plant"	13.0	6.7	3.5	7.7	12.5	7.3	3.4	7.7
9. (N_2+P_2) soil applic."N, P_2O_5 each at 4.0 gm	17.2	6.5	3.8	9.2	11.6	7.3	3.3	7.4
10.(N_2+K_2) soil applic."N, K_2O each at 4.0 gm	8.5	2.9	2.3	4.6	9.9	4.5	2.1	5.5
11.(N_2+P_2+K_2) soil applic."N,P_2O_5,K_2O each at 4.0 gm	8.6	4.3	1.9	4.9	10.1	4.3	2.2	5.5
12. P foliar application 0.5% orthophosphoric acid.	—	—	2.4	—	—	—	2.3	—
L.S.D. . . . . at 5 % level	1.18	0.90	0.70	—	1.00	0.45	0.74	—
. . . . . at 1 % level	1.61	1.23	0.96	—	1.36	0.62	1.00	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used, except the 12th. treatment, since orthophosphoric acid at 0.5% conc. was used.

goes in line with that reported by Youssef et al.,(1985). However, the harmfull effect of the higher rate of N soil application was supported by the findings of Abu-Rumh,(1969) and Abo-Taleb,(1987) on olive seedlings as well as Inoue and Akashi,(1972) on Satsuma. In addition, the benificial effect of P soil application at both two levels used, as well as the increase due to the K application were in harmony with that reported by Milella and Deidda,(1975), Farid,(1979) and EL-Deeb,(1982). Besides, the drastic effect of P soil application at P_2 level when was added together with the higher N level was coincided with that mentioned by Tattini et al.,(1986).

IV. 1.4. Root dry weight:

IV. 1.4.a. Experiment, I :

From data presented in Table (9), it is clear that all the different foliar spray treatments used in experiment "I" resulted in an increase in the root dry weight of the applied nursery plants of both olive cvs. over the check treatment during three seasons of study.

Regarding, the effect of both urea 1% and ammonium sulphate 1% foliar spray treatments obtained data revealed that the stimulation effect of both treatments was highly significant, except with the urea 1% sprayed plants of Manzanillo and those of Picual which received $(NH_4)_2 SO_4$ solu-

tion during 1988 and 1989 seasons, respectively. On the other hand, both two N sources showed statistically the same influence on root dry weight of both Picual and Manzanillo plants, except with the latest cv. where the urea was the superior in 1987 season.

Concerning root dry weight in response to Zn SO_4 500 ppm spray treatment, present result showed a highly significant increase over control during three seasons with both olive cultivars. As for the GA 100 ppm foliar spray, Table (9) shows that the treatment induced the least increase in root dry weight over the control as compared with the other foliar spray treatments used during the three seasons of study, regardless of olive cultivar. Since, the increase in root dry weight due to the GA foliar spray over control was not significant in 1987 and 1988 seasons in applied Manzanillo plants, as well as the same was true with Picual in 1989 season.

With respect to the effect of the foliar spray with zinc sulphate at 500 ppm combined either with urea or ammonium sulphate 1% on the root dry weight, data in Table (9) showed that both treatments were the superior as compared either with control from one hand or with the other used treatments from the other. Differences were highly significant when compared with control. While as compared the "urea + Zn SO_4" or the "$(NH_4)_2$ SO_4 + Zn SO_4" sprayed plants each with those received the corresponding N solution

solely, differences were varried. Since highly significant increase was occurred during 1987 and 1989 seasons but in 1988 season the increase was insignificant in Picual nursery plants. However, in Manzanillo rooted cuttings the increase in root dry weight caused by adding Zn SO_4 to urea 1% or $(NH_4)_2SO_4$ 1 % solutions was highly significant during 1987 and 1988 seasons when compared with those received the corresponding N solution alone, but in 1989 season the difference was so small to reach the significant level.

On the contrary, as the GA was combined to urea or ammonium sulphate a decrease was generally observed, although it was insignificant in most cases. In other words both (urea + GA) and (ammonium sulphate + GA) treatments were statistically of the same effect on the root dry weight when compared with urea 1% and ammonium sulphate 1% respectively, With few exceptions in both olive cvs.

The obtained data concerning the effect of urea, ammonium sulphate foliar sprays on the root dry weight are in confirmity with that reported by **Sharaf** et al.,(1984) and Youssef et al.,(1985). Moreover, finding of Bakhshi et al.,(1973) coincided the present data regarding the effect of zinc application on root system.

As for the effect of GA on root weight, present results are in partial agreement with those reported by **Sharaf** et al.,(1984). However, the stimulative effect of the different treatments that encloding Zn SO_4 either solely or combined

with any of the urea and ammonium sulphate solutions could be discussed by the pronouncing effect of such treatments on a well developed leaves as previously mentioned. This in turn will be reflected positively on developing of a vigorous root system.

IV. 1.4.b. Experiment, II:

With respect to the effect of both application methods and rate of N fertilizer on root growth "dry weight" of both Picual and Manzanillo rooted cuttings, data in Table (10) showed that the ammonium sulphate sprayed plants produced significantly heavier roots than control in both cultivars during three seasons of study. Such increase was highly significant, except in 1987 season where the difference in Manzanillo rooted cuttings was significant at the level of 5% only. On the other hand, foliar spray of ammonium sulphate exceeded the soil application either at lower rate (2.0 gm. actual N/plant) or the higher rate (4.0 gm.) during all seasons of study, regardless of olive cv.. However, the increase in root dry weight of the $(NH_4)_2SO_4$ 1 % sprayed plants was highly significant than those received the higher level of $(NH_4)_2SO_4$ soil application in both olive cultivars during three seasons of study. While the decrease in the root dry weight due to the soil application of $(NH_4)_2SO_4$ at the lower rate (2.0 gm. N/plant) was not pronounced and it was not significant as compared to those of the $(NH_4)_2SO_4$

1% foliar sprayed ones during 1987 and 1988 seasons in Manzanillo and both two cultivars, respectively.

Regarding, soil application of superphosphate either at 2.0 or 4.0 gm. P_2O_5/plant, obtained data revealed that both treatments increased significantly the root dry weight over control in both Picual and Manzanillo rooted cuttings during three seasons of study. On the other hand, as the the rate of superphosphate was concerned it is obvious that the P_2 level (4.0 gm. P_2O_5/plant) was statistically the superior in Manzanillo rooted cuttings, especially during 1987 and 1988 seasons as well as when the average of three seasons was compared. While, with Picual no definite trend was observed, where in 1987 the rate of 2.0 gm. P_2O_5 per plant was the superior but the opposite was found in 1988 season as well as in 1989 seasons both P levels were statistically of the same effect.

It could be concluded that the heavier root dry weight was that of the nursery olive plants that fertilized with superphosphate either at 2.0 or 4.0 gm. P_2O_5 per plant with Picual and Manzanillo cvs., respectively as an average of the three seasons was compared.

Reffering to, the soil application of potassium sulphate, data in **Table (10)** cleared that both two levels of K_2SO_4 applied resulted in increasing the root dry weight of both olive cvs. during three seasons of study. Such increase over control was highly significant, for Picual cv. during

three seasons of study, regardless of K_2O rate. Although with Manzanillo cv. the aforesaid trend in Picual cv. was found during 1988 and 1989 seasons but in 1987 season the differences were significant at the level of 5% only or negligible as the low and high K_2O levels were compared, respectively. In addition, no specific tendency could be achieved in comparison between both K fertilizer levels concerning the effect on root dry weight. Since, in Picual cv. no significant differences were detected during 1987 and 1989 seasons but root dry weight of K_2 applied plants during 1988 was significantly higher. As well as, in Manzanillo cv. the low K rate was the superior during 1987 and 1988 seasons, while in 1989 season the response took the other way around.

With respect to the effect of the different N,P,K combinations used in experiment "II" on the root dry weight Table (10) shows that the (N_2 + P_2) treatment not only surpassed statistically the control, but also exerted the other combinations used during all seasons of study with both cvs.. On the other hand, the (N_2 + K_2) applied olive plants showed the lowest value of root dry weight. Such inhibition was highly significant as compared with control during 1987 and 1988 seasons but it was negligible in 1989 season, regardless of olive cultivar. In addition, root dry weight of the nursery olive plants received the (N_2 + K_2 + P_2) treatment tended to be relatively heavier than those of control especially in Picual cv. as an average of three seasons

Table (10): Variation in root dry weight of Picual and Manzanillo rooted cuttings in relation to level, application method and some combinations of N, P, K fertilizers during three successive 1987, 1988 and 1989 seasons.

Treatments *	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "no fertilizer application"	7.8	2.6	1.9	4.1	7.5	4.7	1.4	4.6
2. N foliar applic. "1% $(NH_4)_2 SO_4$"	11.6	4.6	3.5	6.6	8.3	5.8	2.7	5.6
3. N_1 soil applic. "2 gm. N/plant"	8.7	4.7	2.1	5.2	7.6	5.5	2.1	5.1
4. N_2 soil applic. "4 gm. N/plant"	6.5	2.9	2.0	3.8	6.3	3.5	1.9	4.0
5. P_1 soil applic. "2 gm. P_2O_5 / plant"	11.1	5.0	3.6	6.6	8.5	5.9	2.5	5.6
6. P_2 soil applic. "4 gm. P_2O_5 / plant"	8.8	6.0	3.3	6.0	10.4	7.7	2.5	6.9
7. K_1 soil applic. "2 gm. K_2O / plant"	10.0	3.6	3.5	5.7	8.4	8.9	2.1	6.5
8. K_2 soil applic. "4 gm. K_2O / plant"	9.6	4.8	3.4	5.9	7.4	6.4	2.7	5.5
9. (N_2+P_2) soil applic. N, P_2O_5 each at 4.0 gm.	9.1	3.9	2.8	4.8	8.4	6.0	2.5	5.6
10. (N_2+K_2) soil applic. N, K_2O each at 4.0 gm.	5.4	2.1	2.1	3.2	5.6	3.1	1.8	3.5
11. $(N_2+P_2+K_2)$ soil applic M, P_2O_5, K_2O each at 4 gm	8.2	3.1	2.2	4.5	7.4	4.3	2.6	4.7
12. P foliar application 0.5% orthophosphoric acid.	—	—	2.3	—	—	—	1.5	—
L.S.D. . . . . at 5 % level	0.72	0.40	0.70	—	0.76	0.34	0.60	—
. . . . . at 1 % level	0.99	0.50	0.95	—	1.04	0.46	0.83	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used , except the 12th. treatment, since orthophosphoric acid at 0.5% conc. was used.

was concerned. But the difference was significant in 1988 and 1989 seasons for Picual and Manzanillo cvs., respectively.

Regarding the P foliar application treatment, data in Table (10) revealed that the 0.5 % orthophophoric sprayed plants was not appreceably affected as compared to control concerning the root dry weight response in 1989 season.

The obtained result concerning the effect of N foliar application "1% $(NH_4)_2 SO_4$" is in confirmity with that previously mentioned by **Milella and Deidda,(1975)** on potted olive seedlings, and **Sharaf et al.,(1984)** on some Citrus rootstock seedlings. Moreover, the retardation in root dry weight due to application of ammonium sulphate at the rate of 4.0 gm. actual N/plant either alone or together with potassium sulphate at 4.0 gm. K_2O /plant could be explained on the fact that such highly soluble fertilizers at the higher rate caused a harmfull influence to root system as previously mentioned by **Abu-Rumh,(1969)** and recently **Abo-Taleb,(1987)** on young olive plants when received high N doces. However, the presenl results concerning phosphorus and potassium fertilization behave the same as findings of several investigators. **Farid, (1979)** and **Youssef et al.,(1985)** on olive and some Citrus rootstock seedlings, respectively.

Conclusively, soil application of superphosphate either at 2.0 gm. or 4.0 gm. P_2O_5/plant and the N foliar applica-

tion with 1% $(NH_4)_2SO_4$ solution being to be the most effective treatments concerning their benificial effect on root growth of both Picual and Manzanillo nursery plants.

IV. 1.5. Total plant dry weight :

IV. 1.5.a. Experiment, I :

From data presented in Table (11) it is quite evident that all the foliar spray treatments used in experiment"1" resulted in increasing the total plant dry weight of both olive cultivars than control during three seasons of study. Such increase was highly significant in Picual cv., but with Manzanillo cv. few exceptions were observed viz. Zn SO_4 500 ppm in 1987 season and both treatments of urea 1% and $(NH_4)_2SO_4$ 1% during 1988 season induced a significant increase at the level of 5% only. On the other hand, as both N sources were compared, data obtained revealed that urea 1% foliar sprays tended to be more effective than the ammonium sulphate treatment. This trend was true as data of each season were compared, except in 1988 season where the difference was not significant for both cultivars.

However, both zinc sulphate at 500 ppm and GA at 100 ppm treatments showed relatively a comparable influence on total plant dry weight when they were compared. While Zn SO_4 at 500 ppm was statistically the superior in 1988 seasons for both olive cvs.

Referring to combinations of both urea and ammonium sulphate either with $ZnSO_4$ or GA, Table (11) shows that "urea 1% + $ZnSO_4$ 500 ppm" sprayed plants of Picual cv. were statistically of the same total plant dry weight as compared with those of urea 1% sprayed ones during 1988 and 1989 seasons, while in 1987 season the "urea 1% + $ZnSO_4$ 500 ppm" sprayed plants were statistically heavier.

However, the foliar sprayed plants of Manzanillo cv. with urea alone showed a highly segnificant increase in their total plant dry weight over those sprayed with urea + $ZnSO_4$ during 1987 and 1989 seasons, but in 1988 season the sprayed plants with urea alone were the inferior as their total plant dry weight was compared. Moreover, as both $(NH_4)_2SO_4$ 1% and $(NH_4)_2SO_4$ + $ZnSO_4$ treatments were compared, two opposite trends were detected in both cultivars during each season.

Meanwhile, the foliar spray treatments of the combined gibberellin with both solutions of the two N sources showed generally the same effect when both combinations of "urea + GA" and "$(NH_4)_2SO_4$ + GA" were compared individually each to the corresponding N solution with no GA added. This trend was true with (urea 1% + gibberellin 100 ppm) when compared with urea 1% treatment where the total plant dry weight values did not statistically differ, except in 1988 season in Picual olive cv. only. However, combination of ammonium sulphate plus gibberellin treatment showed a significant in-

Table (11): Total plant dry weight in response to foliar spray with 2 N sources , Zn and gibberellin in rooted cuttings of Picual and Manzanillo olive cvs. during the three successive 1987 , 1988 and 1989 seasons.

Spray treatments	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "water spray"	25.4	10.5	6.5	14.1	24.6	15.7	4.7	15.0
2. Urea 1 %	43.9	14.2	9.0	22.4	32.6	18.1	8.8	19.8
3. Ammonium sulphate 1 %	40.5	15.2	7.4	21.0	29.5	17.9	8.1	18.5
4. Zinc sulphate 500 ppm	38.1	17.9	8.3	21.4	26.1	24.2	6.5	18.9
5. Gibberellin 100 ppm	39.5	14.2	8.1	20.6	27.5	19.3	6.0	17.6
6. Urea 1% + Zn SO_4 500 ppm	46.8	13.7	8.3	22.9	29.3	22.3	7.7	19.8
7. Urea 1% + Gibberellin 100 ppm	44.4	12.3	8.6	21.8	32.7	19.1	8.5	20.1
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	43.7	13.4	8.5	21.9	27.1	19.9	7.0	18.0
9. $(NH_4)_2$ SO_4 + GA 100 ppm	49.5	15.7	8.5	24.6	27.0	21.5	8.6	19.0
L.S.D. . . . . at 5 % level	2.85	1.27	0.83	——	1.42	1.88	0.70	——
. . . . . at 1 % level	3.84	1.70	1.11	——	1.92	2.56	0.95	——

crease over $(NH_4)_2SO_4$ treatment in 1987 and 1989 seasons for Picual as well as during 1988 in Manzanillo.

Generally it could be concluded that all foliar spray treatments enhanced growth of the nursery olive plants of both cultivars over the check treatment "control". In addition, as an average of the three seasons was concerned the different treatments could be arranged for each olive cultivar concerning the total plant dry weight in the following descending order :

1. Picual olive cv.:

The "$(NH_4)_2$ SO_4 + gibberellin 100 ppm" was the superior, both "urea 1% + Zn SO_4 500 ppm" or urea 1% solely came second, both ammonium sulphate and Zn SO_4 either solely or combined together as well as (urea + GA) ranked the third category and finally the gibberellin 100 ppm treatment came latest just before the control.

2. Manzanillo cv. :

All the urea foliar spray solutions i.e. urea, (urea + Zn SO_4), (urea + GA) treatments were the most effective ones, followed by ammonium sulphate and its combinations as well as Zn SO_4 solution and GA foliar spray which ranked the last, then control.

The obtained results are supported by the findings of

Milella and Deidda,(1975) and Ferreira et al.,(1980) concerning the response of the young olive plants to N applications. Moreover, Sharaf and Khamis,(1984) suggested the same finding concerning the stimulation effect of Zn SO_4 foliar sprays.

Besides, similar pattern of the response due to GA foliar application was reported by Badr and Hartmann, (1972), Bartolini and Ministro,(1981) and Abo-Taleb,(1987) on olive nursery plants.

IV. 1.5.b. Experiment, II :

Concerning the response of total plant dry weight to the different treatments applied in the second experiment, data from Table (12) revealed that N foliar application with 1% $(NH_4)_2$ SO_4 resulted in a highly significant increase over control during three seasons of study, regardless of olive cultivar. However, the N soil application of ammonium sulphate at the low rate (2.0 gm. N/plant) showed an increase in the treated nursery olive plants. This increase was not significant during both 1987 and 1989 seasons as well as in 1988 season for Picual and Manzanillo rooted cuttings, respectively. Besides, the soil applied plants with ammonium sulphate at the higher rate (4.0 gm. actual N/plant) were significantly the lightest plants as their total dry weight was compared with those of the other two N treatments, where the differences were highly significant. On the other hand,

Table (12): Variation in total plant dry weight of Picual and Manzanillo rooted cuttings in relation to level, application method and some combinations of N, P, K fertilizers during three successive 1987, 1988 and 1989 seasons.

Treatments *	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "no fertilizer application"	25.4	10.5	6.5	14.1	24.6	15.7	4.7	15.0
2. N foliar applic. "1% $(NH_4)_2 SO_4$"	40.5	15.2	11.1	22.3	29.5	18.0	8.4	18.8
3. N_1 soil applic. "2 gm. N/plant"	26.7	13.2	7.2	15.7	28.1	15.4	7.2	16.9
4. N_2 soil applic. "4 gm. N/plant"	24.6	7.4	5.8	12.6	24.3	10.1	5.2	13.2
5. P_1 soil applic. "2 gm. P_2O_5/plant"	43.3	15.7	8.8	22.6	24.7	21.0	8.0	17.9
6. P_2 soil applic. "4 gm. P_2O_5/plant"	29.8	18.2	8.9	19.0	31.9	22.7	7.3	20.6
7. K_1 soil applic. "2 gm. K_2O /plant"	38.9	12.0	10.3	20.4	29.7	28.0	7.5	21.7
8. K_2 soil application "4 gm. K_2O/plant"	34.4	15.6	10.4	20.1	28.6	19.9	8.3	18.9
9. (N_2+P_2) soil applic."N, P_2O_5 each at 4.0 gm"	37.7	11.8	9.4	19.6	28.1	17.9	7.7	17.9
10.(N_2+K_2) soil applic. "N, K_2O each at 4.0 gm"	19.2	6.7	6.3	10.7	21.4	9.7	6.2	12.4
11.(N_2+P_2+K_2) soil applic. "N, P_2O_5, K_2O each at 4gm	25.4	9.5	5.3	13.4	25.6	11.3	6.0	14.3
12. P foliar application 0.5% orthophosphoric acid.	—	—	6.9	—	—	—	5.5	—
L.S.D. . . . . at 5 % level	2.40	0.80	0.67	—	3.34	0.83	1.56	—
. . . . . at 1 % level	3.30	1.20	0.92	—	4.55	1.14	2.13	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used, except the 12th. treatment, since orthophosphoric acid at 0.5% conc. was used.

N_2 soil applied plants were relatively stunted as compared with control, where the decrease in their total dry weight was highly significant in 1988 season with both cv., but during both 1987 and 1989 seasons the decrease was less pronounced.

With respect to the soil application of superphosphate either at 2.0 or 4.0 gm. P_2O_5 per plant, data from Table (12) disclosed that an obvious increase in the total plant dry weight was gained as compared with control during all seasons of study in both olive cultivars. On the other hand, the P_1 soil application seemed to be more effective than the P_2 rate with Picual cv., while the reverse was true with Manzanillo cv. as an average of the three seasons was concerned. In addition, the superphosphate soil application either at the rate of 2.0 gm. or 4.0 gm. P_2O_5 per plant were the superior treatments when average of the three seasons was compared with those of the other treatments used in the second experiment for Picual and Manzanillo cvs., respectively.

Regarding the effect of potassium soil application, data obtained showed that both rates(2.0/4.0 gm. K_2O/plnat) enhanced significantly the growth over control. The increase was highly significant during all seasons of study in both cultivars. However, no specific trend could be detected when both rates of potassium were compared during each season, where variable degrees of response were observed. Since both

K_1 and K_2 treatments showed two opposite trends in 1987 and 1988 seasons in Picual rooted cuttings, while with Manzanillo the tendency of reacting did not conflict during the same both seasons. Besides, during 1989 season both rates of potassium soil application were approximately the same with both olive cultivars.

As for the different combinations of N,P,K fertilizers used, it is quite evident from data in Table (12) that a highly significant increase in the total plant dry weight was occured when ammonium sulphate (4.0 gm N/plant) and superphosphate (4.0 gm. P_2O_5/plant) were applied together via (N_2 + P_2) treatment. This trend was true when the (N_2 + P_2) treated plants were compared with control on one hand and with the other N,P,K combinations i.e. (N_2 + K_2) and (N_2+P_2+K_2) treatments on the other during all seasons, regardless of olive cultivar. Moreover, the soil application of both ammonium sulphate and potassium sulphate together in combination each at the higher rate i.e. (N_2 + K_2) treatment was the least effective application, where it produced the lightest total plant dry weight. The difference was highly significant when compared either with control or any of the other used treatments. In addition, (N_2 + P_2 + K_2) treatment was in between as compared with both (N_2 + P_2) and (N_2 + K_2) treatments. In other words, the adding of superphosphate to the (N_2 + K_2) mixture resulted in reducing its stunting effect on total plant dry weight. This effect may be due to the beneficial influence of phosphorus on root formation

which in turn will be reflected positively on improving the development of the different organs in the applied nursery plants of both olive cultivars.

However, the P foliar spray treatment showed an increase in the total plant dry weight than control, but it was so small to reach the level of significance.

The present findings are coincided by those of Milella and Deidda,(1975),Ferreira et al.,(1980) and Ferreira,(1982) concerning the improving effect of the N application on the vegetative growth of young olive plants. On the contrary, the depressing effect of the high level of N soil application was in partial agreement with that reported by Abu-Rumh,(1969) and Abo-Taleb,(1987). The beneficial effect of phosphorus application was supported by the earlier findings of Bouat et al.,(1954), Milella and Deidda,(1975) and Farid,(1979), all suggested the necessity of phosphorus fertilization for the best vegetative growth of olive nursery plants. In addition, data obtained concerning the effect of K fertilizer applications goes partially in line with that reported by EL-Deeb,(1982) on two Citrus rootstock seedlings.

IV. 1.6. Top/root ratio :

IV. 1.6.a. Experiment, I :

Concerning the effect of the differential treatments

Table (13): Top/root ratio of rooted cuttings of Picual and Manzanillo olive cvs. in response to foliar spray with two N sources, Zn and gibberellin during three successive 1987, 1988 and 1989 seasons.

Spray treatments	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "water spray"	2.2	3.0	2.4	2.5	2.2	2.3	2.4	2.3
2. Urea 1 %	3.0	2.3	2.6	2.6	2.3	2.4	2.3	2.3
3. Ammonium sulphate 1 %	2.5	2.3	2.5	2.4	2.6	2.1	2.0	2.2
4. Zinc sulphate 500 ppm	2.4	2.2	2.2	2.3	1.9	1.7	1.9	1.8
5. Gibberellin 100 ppm	2.6	2.2	2.6	2.5	2.7	2.6	2.2	2.5
6. Urea 1% + Zn SO_4 500 ppm	2.5	2.3	1.8	2.2	2.3	1.7	1.7	1.9
7. Urea 1% + Gibberellin 100 ppm	3.1	2.8	2.4	2.8	3.4	2.6	2.6	2.9
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	2.3	1.7	1.9	2.0	1.9	1.9	1.4	1.7
9. $(NH_4)_2$ SO_4 + GA 100 ppm	3.0	2.2	2.2	2.5	2.7	2.5	2.7	2.6
L.S.D. . . . . at 5 % level	1.09	0.58	0.25	——	0.15	0.40	0.17	——
. . . . . at 1 % level	1.46	0.79	0.33	——	0.19	0.40	0.23	——

used in the first 'foliar sprays" experiment on the top/root ratio data are presented in Table (13). It is obvious that the highest ratio was that of the nursery olive plants which sprayed with gibberellin either alone or combined with any of the two N sources, as well as those of the urea 1% sprayed plants. Such trend was more pronounced in Manzanillo cv. Since, GA 100 ppm, (urea 1% + GA 100 ppm) and (ammonium sulphate 1% + GA 100 ppm) foliar sprays treatments statistically resulted in increasing the ratio over the other treatments applied on one hand, as well as over the control on the other during three seasons of study with Manzanillo cultivar. Meanwhile, in Picual cv. the trend to some extent was similar to that previously mentioned with Manzanillo cv., but differences were not significant in some cases. On the contrary, foliar application of zinc sulphate at 500 ppm either solely or in combinations with urea / ammonium sulphate decreased obviously the top/root ratio of both Picual and Manzanillo nursery olive plants. The decrease was highly significant as compared with the other treatments, especially those of Manzanillo which sprayed with any of GA, $(NH_4)_2 SO_4$, urea and their combinations during three seasons of study. While in Picual the reduction in top/root ratio was significant at 5% level only.

In addition, differences in top/root ratio in relation to nitrogen source was insignificant in Picual cv. during three seasons of study. However, the same trend was true in 1987 season for Manzanillo cv., but during both 1988 and

1989 seasons the ratio of the urea 1% sprayed plants was significantly higher over those of the $(NH_4)_2SO_4$ 1% sprayed ones.

Variation in top/root ratio could be generally explained by the unparallelled response of growth in both obove and under ground plant organs to the different treatments used as previously mentioned. Since, the increase in top/root ratio due to foliar sprays with gibberellin either solely or combined with urea/ammonium sulphate could be discussed on the fact that the obove ground organs were more responded to such treatments than the under ground one. Besides, the pronounced response of the root system to zinc sulphate offers a suitable and logic explanation to the decrease in the ratio of the nursery olive plants received any of the different zinc sulphate treatments.

IV. 1.6.b. Experiment, II :

Concerning the effect of the different treatments included in the second experiment on the top/root ratio, data are presented in Table (14). The obtained data revealed that the ratio was not greetly differed in the $(NH_4)_2 SO_4$ foliar sprayed olive plants as compared to control. This could be easily explained that both the obove and under ground organs were equally responded to the $(NH_4)_2 SO_4$ 1% foliar sprays. Meanwhile, the ratio tended to be decreased when the $(NH_4)_2 SO_4$ fertilizer was applied to soil at the higher level (N_2

Table (14): Top/root ratio of Picual and Manzanillo rooted cuttings in relation to level, application method and some combinations of N, P, K fertilizers during three successive 1987, 1988 and 1989 seasons.

Treatments *	Picual				Manzanillo			
	1987	1988	1989	Aver.	1987	1988	1989	Aver.
1. Control "no fertilizer application"	2.2	3.0	2.4	2.5	2.2	2.3	2.4	2.3
2. N foliar applic. "1% $(NH_4)_2 SO_4$"	2.5	2.3	2.2	2.3	2.6	2.3	2.1	2.3
3. N_1 soil application "2 gm. N/plant"	2.2	1.9	2.5	2.2	2.7	2.1	2.8	2.6
4. N_2 soil application "4 gm. N/plant"	2.8	1.6	1.4	1.9	2.8	2.0	2.1	2.3
5. P_1 soil applic. "2 gm. P_2O_5/plant"	2.9	2.1	1.4	2.1	1.8	2.6	2.1	2.2
6. P_2 soil applic. "4 gm. P_2O_5/plant"	2.4	2.0	1.7	2.0	2.1	2.0	1.9	2.0
7. K_1 soil applic. "2 gm. K_2O /plant"	2.9	2.4	2.0	2.4	2.6	2.2	2.6	2.5
8. K_2 soil application "4 gm. K_2O/plant"	2.6	2.3	2.0	2.3	2.8	2.1	2.0	2.3
9. (N_2+P_2) soil applic. "N, P_2O_5 each at 4.0 gm."	3.1	2.7	2.2	2.7	2.4	2.0	2.4	2.3
10. (N_2+K_2) soil applic. "N, K_2O each at 4.0 gm."	2.5	2.2	2.0	2.2	2.8	2.1	2.4	2.4
11. (N_2+P_2+K_2) soil applic. "N, P_2O_5, K_2O each at 4gm	2.1	2.1	1.5	1.9	2.5	1.6	1.5	1.9
12. P foliar application 0.5% orthophosphoric acid.			1.9	—	—	—	2.6	—
L. S. D. . . . . at 5 % level	0.50	0.34	0.38	—	0.34	0.12	0.34	—
. . . . . at 1 % level	0.62	0.47	0.51	—	0.47	0.16	0.47	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N, P, K fertilizers used, except the 12th. treatment, since orthophosphoric acid at 0.5% conc. was used.

treatment) especially during 1988 and 1989 seasons as compared either to control or $(NH_4)_2 SO_4$ foliar spray. Moreover, the N soil application at the lower rate (2.0 gm actual N/plant) was in between as compared with both the aforementioned N treatments. The decrease in the top/root ratio resulted from the N_2 soil application due to the more pronounced depression of this treatment on growth of the aerial "shoot" system than that observed in root system.

Regarding, the soil application of superphosphate either at 2.0 gm or 4.0 gm P_2O_5 per plant, Table (14) shows that both treatments decreased generally the top/root ratio as compared with control. Such decrease was more pronounced in the P_2 fertilized plants especially with Manzanillo cv., where differences were significant during 1988 and 1989 seasons. While in 1987 season it was negligible. Stimulation in growth of root system due to the phosphorus fertilization as previously mentioned offers a logic discussion for the detected decrease in the top/root ratio of the phosphorus applied olive plants.

However, no general trend could be achieved concerning the effect of potassium soil application. Besides, the ratio was significantly decreased as the potassium fertilizer was applied at the rate of 4.0 gm K_2O per plant when compared either with control or with the K_1 treatment during both 1988 and 1989 seasons. On the other hand, the reverse was true in 1987 season. Consequently, as an average of the

three seasons was concerned both potassium treatments were to some extent of the same effect from one hand and similar to control on the other.

As for the different N,P,K combinations used, obtained data revealed that the (N_2 + P_2 + K_2) treatment induced statistically the lowest top/root ratio when compared either with the other two combinations of the N,P,K fertilizers investigated in the second experiment or with any of the other treatments. Such trend was generally true except with Picual when the N_1 and N_2 treatments were compared with the (N_2+P_2+K_2) one in 1988 season. In addition, both (N_2+P_2) and (N_2+K_2) treatments were similar with Manzanillo cv. regarding their effect on the top/root ratio. While in Picual cv. the ratio was relatively higher in the (N_2+P_2) applied nursery plants as compared with that of (N_2+K_2) treatment during three seasons of study.

The obtained results concerning the top/root ratio as influenced by the different treatments could be discussed on the fact that the responses of the different plant organs to the different treatments used were not parallelled as previously mentioned.

In this concern, it could be concluded that P soil application either solely or combined with (N+K), as well as the N_2 soil application lead to increasing the top/root ratio in general.

IV. 2. Mineral composition :-

The effect of foliar spray with two-N sources, Zn SO_4 and GA either alone or in combination (Experiment,I) as well as the rate, application method and some combinations of N,P,K fertilizers (Experiment,II) on mineral composition of leaf, stem and root in Picual and Manzanillo rooted cuttings during 1987 and 1988 seasons was studied.

IV. 2.1. Nitrogen content :

IV. 2.1.a. Experiment,I :-

The data concerning the effect of foliar sprays with urea at 1%, $(NH_4)_2$ SO_4 at 1%, Zn SO_4 at 500 ppm, GA at 100 ppm and their combination treatments on leaf, stem and root-N content are presented in Tables (15 & 16).

It is clear from the data obtained that N applied either as urea at 1% or $(NH_4)_2$ SO_4 at 1% foliar spray treatments showed highly significant increase in leaf, stem and root-N content in both two olive cvs. as compared with the control during 1987 and 1988 seasons. These results are in harmony with that reported by Ferriera et al.,(1980) on urea foliar application of Picual olive trees, Abo-Taleb,(1987) on NH_4 NO_3 on Shemlali olive seedlings and Khamis et al.,(1984) on urea foliar spray of Cleopatra mandarin, sour orange and rough lemon seedlings. On the other

Table (15): Nitrogen percentage in leaves, stem and roots of Picual rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1. Control "Water spray"	0.63	0.70	0.67	0.43	0.51	0.47	0.69	0.50	0.60
2. Urea 1 %	1.70	1.54	1.62	0.71	0.61	0.66	1.03	1.00	1.02
3. Ammonium sulphate 1%	1.75	1.66	1.71	1.05	0.75	0.90	1.22	1.10	1.16
4. Zinc sulphate 500 ppm	0.65	0.71	0.68	0.45	0.53	0.49	0.70	0.51	0.61
5. Gibberellin 100 ppm	1.35	1.27	1.31	0.69	0.66	0.68	0.99	0.82	0.91
6. Urea 1% + Zn SO_4 500 ppm	1.60	1.74	1.67	0.54	0.83	0.69	1.10	1.01	1.06
7. urea 1% + Gibberellin 100 ppm	1.56	1.58	1.57	0.71	0.79	0.75	1.15	1.11	1.13
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	1.36	1.51	1.44	0.83	0.62	0.73	1.04	0.88	0.96
9. $(NH_4)_2$ SO_4 1% + GA 100 ppm	1.44	1.52	1.48	0.52	0.77	0.65	1.16	1.02	1.09
L.S.D. . . . . at 5 % level	0.05	0.12	—	0.05	0.05	—	0.15	0.05	—
. . . . . at 1 % level	0.07	0.16	—	0.07	0.07	—	0.19	0.07	—

Table (16): Nitrogen percentage in leaves, stem and roots of Manzanillo rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "Water spray"	1.05	0.85	0.95	0.46	0.53	0.50	0.65	0.66	0.66
2.Urea 1 %	1.55	1.46	1.51	0.69	0.61	0.65	1.08	0.95	1.02
3.Ammonium sulphate 1%	1.25	1.36	1.31	0.59	0.61	0.60	0.90	0.80	0.85
4.Zinc sulphate 500 ppm	1.05	0.85	0.95	0.45	0.54	0.50	0.65	0.64	0.65
5.Gibberellin 100 ppm	1.25	1.28	1.27	0.59	0.63	0.61	0.98	0.83	0.91
6.Urea 1% + Zn SO_4 500 ppm	1.52	1.98	1.75	0.85	0.78	0.82	1.31	1.13	1.22
7.urea 1% + Gibberellin 100 ppm	1.59	1.77	1.68	0.63	0.77	0.70	1.26	1.14	1.20
8.$(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	1.36	1.46	1.41	0.68	0.70	0.69	1.26	0.83	1.05
9.$(NH_4)_2$ SO_4 1% + GA 100 ppm	1.40	1.97	1.69	0.78	1.10	0.94	1.06	1.19	1.13
L.S.D. . . . . at 5 % level	0.05	0.07	—	0.12	0.08	—	0.12	0.05	—
. . . . . at 1 % level	0.07	0.10	—	0.16	0.13	—	0.16	0.07	—

hand, $(NH_4)_2 SO_4$ foliar spray treatment significantly increased leaf, stem and root-N % in Picual olive variety as compared with urea foliar spray, while in Manzanillo olive cv. no different between urea and $(NH_4)_2 SO_4$ foliar spray treatments was occurred during the two seasons of study. (Zn SO_4) at 500 ppm foliar spray treatment did not affect N level in leaf, stem and root as compared with the control in both Picual and Manzanillo rooted cuttings during 1987 and 1988 seasons. The present results were confirmed with the findings of **Labanauskas et al.,(1963)** on Washington navel orange, **Labanauskas and Puffer,(1964)** on Valencia orange trees, and **Khadr et al., (1978)** on Washington navel orange.

Gibberellin at 100 ppm foliar spray treatment significantly increased leaf, stem and root-N content in both two olive cvs. during the two seasons of study. This results are confirmed by the findings of **Abo-Taleb,(1987)** on Shemlali olive seedlings, and **Khamis et al.,(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings.

(Urea + Zinc sulphate) and ($(NH_4)_2$ + Zn SO_4) foliar spray treatments caused highly significant increase in leaf, stem and root-N content as compared with the control in both olive cvs. during 1987 and 1988 seasons. This results are confirmed by the findings of **EL-Shazly,(1980)** on Valencia orange trees.

In addition, (urea + GA_3) and ($(NH_4)_2$ SO_4 + GA_3) foliar spray treatments significantly increased leaf, stem and

root-N content over control in both Picual and Manzanillo olive rooted cuttings during the study. This result is similar to that reported by Mougheith et al.,(1979) and Khamis et al.,(1984) on Cleopatra mandarin, sour orange and rough lemon seedlings.

Generally, it could be concluded that leaf, stem and root-N content of both Picual and Manzanillo olive rooted cutting was increased obviously by all foliar spray treatments over, control, except with Zn SO_4 treatment where N level in leaf, stem and root was not affected in both two olive cvs. during the two seasons of study. Furthermore, it is clear that nitrogen percentage in leaves was generally higher than those of stem and root in both olive cvs. during the two seasons of study.

IV. 2.1.b. Experiment,II :

Concerning leaf, stem and root-N content as influenced by application method, rate and combinations of N,P,K fertilizers, data are presented in Tables (17 & 18). It is clear from the results obtained that $(NH_4)_2$ SO_4 applied either as foliar spray at the rate of 1% or soil application at the rate of (2.0 gm or 4.0 gm/ rooted cutting) significantly increased leaf, stem and root-N content over control in both two olive cvs. during the study. These results confirmed past research by Ferriera et al.,(1980) and Abo-Taleb,(1987) on olive seedlings and Khamis et al.,(1984)

on some Citrus rootstock seedlings.

With respect to leaf, stem and root-N content as influenced by application method, data showed that, the soil application with $(NH_4)_2 SO_4$ at the rate of (2.0 gm or 4.0 gm/rooted cutting) caused highly significant increase in leaf, stem and root-N content than those of the foliar spray treatment in both two olive cvs. during the study. On the contrary, **Rajat and Singh,(1963)** stated that foliar application of a fifth or quarter of the usual quantity of nutrient was as effective as the soil dose of nutrient applied to the soil. Also, **Badade,(1966)** found that 50% application of both N and P nutrients to the foliage was equal to soil application of the full amount.

In addition, the effect of $(NH_4)_2 SO_4$ soil fertilizer rate, data from **Tables (17 & 18)** showed that, rising the supply of $(NH_4)_2SO_4$ from (2.0 gm to 4.0 gm/rooted cutting) significantly increased leaf, stem and root-N content in both Picual and Manzanillo olive rooted cutting during 1987 and 1988 seasons. These results are in harmony with that reported by **Klein and Lavee,(1977)** on olive trees, **Leyden, (1963)** on grapefruit trees, **EL-Kassas,(1972)**, **Attalla, (1973)**, **Embleton** et al.,**(1973)** and **Hume** et al.,**(1985)** on Valencia orange trees.

As for superphosphate soil application (P_1 or P_2) treatments, data in **Tables (17 & 18)** showed that superphosphate at the rate of (2.0 gm. or 4.0 gm P_2O_5/ rooted cut-

Table (17): Nitrogen percentage in leaves, stem and roots of Picual rooted cuttings in relation to level , application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatment *	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control"no fertilizer application"	0.63	0.70	0.67	0.43	0.51	0.47	0.69	0.50	0.60
2.N foliar applic."1%$(NH_4)_2SO_4$"	1.75	1.64	1.69	1.05	0.75	0.90	1.11	1.10	1.10
3.N_1 soil applic."2.0 gm N/plant"	2.14	2.02	2.08	0.95	0.92	0.94	1.33	1.13	1.26
4.N_2 soil applic."4.0 gm N/plant"	2.32	2.45	2.38	1.07	1.06	1.06	1.58	1.27	1.43
5.P_1 soil applic."2gm P_2O_5/plant"	1.43	1.57	1.50	0.63	0.71	0.67	0.89	0.46	0.68
6.P_2 soil applic."4gm P_2O_5/plant"	1.45	1.59	1.52	0.72	0.80	0.76	0.93	0.72	0.83
7.K_1 soil applic."2gm K_2O /plant"	1.45	1.45	1.45	0.60	0.63	0.62	1.01	0.66	0.84
8.K_2 soil applic."4gm K_2O /plant"	1.70	1.60	1.65	0.79	0.78	0.78	1.20	0.97	1.09
9.(N_2+P_2) soil applic. "N, P_2O_5 each at 4.0 gm"	1.85	2.28	2.07	0.70	0.82	0.76	1.03	1.13	1.08
10.(N_2+K_2) soil applic. "M, K_2O each at 4.0 gm"	2.19	2.53	2.36	1.20	0.92	1.06	1.31	1.25	1.28
11.(N_2+P_2+K_2) soil applic."N,P_2O_5,K_2O each at 4gm	2.25	2.52	2.39	0.75	0.97	0.86	1.30	1.16	1.23
L.S.D. . . . . at 5 % level	0.12	0.11	—	0.09	0.08	—	0.14	0.12	—
. . . . . at 1 % level	0.16	0.16	—	0.13	0.10	—	0.19	0.16	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used.

ting) caused highly significant increase in leaf, stem and root-N content over control in both two olive cvs. during the study.

These results are similar to that achieved by Farid, (1979), Domanskaya et al.,(1982) on olive plants and Khamis et al.,(1985) on Cleopatra mandarin, Wellolef mandarin and rough lemon seedlings.

Moreover,the effect of superphosphate rate as soil application, data showed that rising the supply P from (2.0 gm. or 4.0 gm. P_2O_5/rooted cutting) showed the same effect. Results were obtained by Domanskaya et al.,(1982). on olive trees.

Regarding the effect of soil application with potassium sulphate (K_1 or K_2) treatments, it is evident from Tables (17 & 18) that K applied significantly increased leaf, stem and root-N content over control in both Picual and Manzanillo rooted cuttings during the study. The same finding were obtained by Khamis et al.,(1985) on five Citrus rootstock seedlings. On the other hand, the obtained data showed that rising the K fertilizer rate from (2.0 gm to 4.0 gm K_2O/rooted cutting) significantly increased leaf, stem and root-N content in both Picual and Manzanillo olive rooted cuttings during 1987 and 1988 seasons. The same trend was reported by Domanskaya et al.,(1982) on olive trees.

(N_2 + P_2) soil application treatment caused highly sig-

nificant increase in leaf, stem and root-N content over control treatment in both two olive cvs. during the two seasons of the study. The results are in agreement with that reported by **Khamis** et al.,(1985), who found that, urea at 1% + P at 200 ppm foliar sprays treatment significantly increased leaf-N content in both Cleopatra mandarin and sour orange seedlings. Moreover, both (N_2+K_2) and (N_2+P_2+K_2) soil application treatments caused highly significant increase in leaf, stem and root-N content over control in both olive cvs. during the study. These results are similar to that reported by **Khamis** et al.,(1985) on some Citrus seedlings.

Generally, it could be concluded that leaf, stem and root-N content of both Picual and Manzanillo rooted cuttings was increased obviously by all treatments of N,P,K fertilizers used in experiment, II.

Moreover, rising the supply of N or K significantly increased leaf, stem and root-N content.

In addition, leaf nitrogen content was higher in the N soil applied olive plants than those of the foliar sprayed ones in both two olive cvs. during the study.

IV. 2.2. Phosphorus content :

IV. 2.2.a. Experiment, I :-

The data concerning the phophorus content of leaf, stem and root as influenced by the differential foliar spray treatments used in experiment I are presented in Tables (19 & 20). It is clear from the results obtained that N-fertilization either as urea at 1% or $(NH_4)_2 SO_4$ at 1% foliar sprays caused highly significant decrease in leaf, stem and root-P content in both Picual and Manzanillo olive rooted cuttings during 1987 and 1988 seasons. These results are in confirmity with the findings of Milella and Deidda,(1978) in Avana mandarin trees and Khamis et al.,(1984) on Cleopatra mandarin, sour orange and rough lemon seedlings. Moreover, $(NH_4)_2 SO_4$ at 1 % foliar sprays treatment showed a significant decrease in leaf, stem and root-P content in both Picual and Manzanillo olive rooted cutting as compared with urea at 1% foliar spray treatment during the study. Since significance was at 5% level during both 1987 and 1988 seasons with both Picual and Manzanillo rooted cuttings.

Zinc sulphate at 500 ppm foliar spray treatment caused highly significant decrease in leaf, stem and root-P content as compared with control in both two olive cvs. during the study. These results are in harmony with that reported by Asma,(1981) on Valencia orange and Khamis (1984) on 5 Citrus

Table (19): Phosphour percentage in leaves, stem and roots of Picual rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1. Control "Water spray"	0.16	0.18	0.17	0.10	0.12	0.11	0.10	0.12	0.11
2. Urea 1 %	0.14	0.12	0.13	0.08	0.09	0.08	0.08	0.09	0.08
3. Ammonium sulphate 1%	0.12	0.11	0.11	0.07	0.08	0.07	0.07	0.08	0.07
4. Zinc sulphate 500 ppm	0.12	0.12	0.12	0.09	0.10	0.10	0.08	0.10	0.09
5. Gibberellin 100 ppm	0.14	0.12	0.13	0.08	0.10	0.09	0.08	0.10	0.09
6. Urea 1% + Zn SO_4 500 ppm	0.10	0.14	0.12	0.08	0.10	0.09	0.07	0.09	0.08
7. urea 1% + Gibberellin 100 ppm	0.14	0.14	0.14	0.07	0.10	0.08	0.06	0.08	0.07
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	0.14	0.16	0.15	0.08	0.10	0.09	0.18	0.16	0.17
9. $(NH_4)_2$ SO_4 1% + GA 100 ppm	0.12	0.14	0.13	0.07	0.08	0.07	0.08	0.06	0.07
L.S.D. . . . . at 5 % level	0.01	0.01	—	0.01	0.01	—	0.01	0.01	—
. . . . . at 1 % level	0.02	0.02	—	0.02	0.02	—	0.02	0.02	—

Table (20): Phosphour percentage in leaves, stem and roots of Manzanillo rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "Water spray"	0.16	0.18	0.17	0.12	0.14	0.13	0.12	0.14	0.13
2.Urea 1 %	0.10	0.10	0.10	0.10	0.12	0.11	0.10	0.11	0.10
3.Ammonium sulphate 1%	0.09	0.09	0.09	0.08	0.11	0.10	0.08	0.09	0.08
4.Zinc sulphate 500 ppm	0.10	0.10	0.10	0.07	0.08	0.07	0.10	0.11	0.11
5.Gibberellin 100 ppm	0.12	0.12	0.12	0.10	0.11	0.10	0.09	0.12	0.10
6.Urea 1% + $ZnSO_4$ 500 ppm	0.12	0.14	0.13	0.10	0.13	0.12	0.10	0.11	0.10
7.urea 1% + Gibberellin 100 ppm	0.14	0.14	0.14	0.10	0.10	0.10	0.11	0.13	0.12
8.$(NH_4)_2SO_4$ 1% + $ZnSO_4$ 500 ppm	0.10	0.14	0.12	0.10	0.12	0.11	0.16	0.16	0.16
9.$(NH_4)_2SO_4$ 1% + GA 100 ppm	0.10	0.14	0.12	0.10	0.10	0.10	0.06	0.08	0.07
L.S.D. . . . . at 5 % level	0.01	0.01	—	0.01	0.01	—	0.02	0.01	—
. . . . . at 1 % level	0.02	0.02	—	0.02	0.02	—	0.03	0.02	—

rootstock seedlings.

In addition, gibberellin at 100 ppm foliar spray treatment significantly decreased leaf, stem and root-P content for both Picual and Manzanillo rooted cuttings during the two seasons of study. This result is in agreement with that mentioned by **Randhawa and Iwata,(1965)** on Citrus masudaidadi seedlings, **EL-Said,(1980)** on Cleopatra mandarin seedlings and **Khamis et al.,(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings.

Besides, both (urea + $Zn\ SO_4$) and [$(NH_4)_2\ SO_4$ + $Zn\ SO_4$] foliar spray treatments significantly decreased leaf, stem and root-P content as compared with the control in both two olive cvs. during 1987 and 1988 seasons. The same finding was obtained by **EL-Shazly,(1980)** on Valencia orange trees.

Moreover, it is quite clear from **Tables (19 & 20)** that (urea 1% + GA 100 ppm) and [$(NH_4)_2\ SO_4$ 1% + GA 100 ppm] foliar spray treatments caused highly significant decrease in leaf, stem and root-P content below the control treatment in both two olive cvs. during the study. These results are confirmed by the findings of **EL-Said,(1980)** on Cleopatra mandarin seedlings and **Khamis et al.,(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings.

The decrease in phosphorus percentage in the three plant organs of the rooted cuttings of Picual and Manzanillo olive cvs. which occured could be explained on the fact that

all the foliar spray treatments used in experiment, I resulted in enhancing growth of such organs which in turn is reflected in an evident dilution of P concentration i.e. P % in the dry matter.

Generally, it could be concluded that leaf, stem and root-P content of both Picual and Manzanillo olive nursery plants was decreased obviously by all foliar spray treatments below the control treatment. In addition, it is clear that phosphorus in leaves was generally higher than those of stem and root in both two olive cvs. under study.

IV. 2.2.b. Experiment, II :-

Concerning leaf, stem and root-P content as influenced by both application methods of ammonium sulphate, as well as fertilizer rate and some combination of N,P,K fertilizers, data are presented in Tables (21 & 22). It is clear from the data obtained that as $(NH_4)_2 SO_4$ was applied either as foliar spray at 1% or soil application at(2.0 gm or 4.0 gm/rooted cutting) leaf, stem and root-P content was significantly decreased in both two olive cvs. during 1987 and 1988 seasons. The same finding was obtained by Kazak and Khalidy,(1976) on Shamouti orange and Valencia orange, Milella and Deidda,(1976) in Avana mandarin and Khamis et al.,(1984) on Cleopatra mandarin, sour orange and rough lemon seedlings.

With respect to leaf, stem and root-P content as influenced by application method of $(NH_4)_2 SO_4$, data showed that the soil application at the lower rate, i.e. 2.0 gm N/ rooted cutting showed a significant increase in leaf, P content in both two olive cvs. . While the reverse was true for stem and root-P % as compared with the foliar spray treatment during 1987 and 1988 seasons. In addition, as the effect of nitrogen fertilizer rate was concerned, data from **Tables (21 and 22)** showed that increasing N supply from 2.0 gm to 4.0 gm actual N/ rooted cuttings caused significant decrease in leaf, stem and root-P content in rooted cuttings of Picual olive, while with Manzanillo rooted cutting an opposite trend was occured during 1987 and 1988 seasons. Nevertheless, data in **Tables (21 & 22)** showed that soil application of superphosphate either at P_1 or P_2 caused highly significant increase in leaf, stem and root-P content as compared with control in both Picual and Manzanillo rooted cuttings during the study. However, the higher rate statistically was more effective. This result is similar to that achieved by **Farid, (1979)** on Mission olive seedlings and **Khamis et al.,(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings as the effect of P fertilizer was concerned.

In addition, concerning the effect of P-soil application rate.

The present data is agreed the finding of **Domanskaya et**

Table (21): Phosphour percentage in leaves, stem and roots of Picual rooted cuttings in relation to level , application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatment *	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control " no fertilizer application"	0.16	0.18	0.17	0.10	0.12	0.11	0.10	0.12	0.11
2.N foliar applic. "1% $(NH_4)_2 SO_4$"	0.12	0.11	0.12	0.07	0.08	0.08	0.07	0.08	0.08
3.N_1 soil applic. "2.0 gm N/plant"	0.14	0.14	0.14	0.07	0.07	0.07	0.07	0.07	0.07
4.N_2 soil applic. "4.0 gm N/plant"	0.13	0.12	0.13	0.06	0.06	0.06	0.06	0.05	0.06
5.P_1 soil applic. "2gm P_2O_5/plant"	0.20	0.24	0.22	0.16	0.16	0.16	0.16	0.20	0.18
6.P_2 soil applic. "4gm P_2O_5/plant"	0.23	0.25	0.24	0.18	0.18	0.18	0.20	0.22	0.21
7.K_1 soil applic. "2gm K_2O /plant"	0.17	0.19	0.18	0.11	0.13	0.12	0.12	0.13	0.13
8.K_2 soil applic. "4gm K_2O /plant"	0.18	0.20	0.19	0.12	0.14	0.13	0.14	0.16	0.15
9. (N_2 + P_2) soil applic."N, P_2O_5 each at 4.0 gm"	0.19	0.20	0.20	0.13	0.15	0.14	0.12	0.14	0.13
10.(N_2 + K_2) soil applic."N, K_2O each at 4.0 gm"	0.16	0.18	0.17	0.10	0.12	0.11	0.10	0.12	0.11
11.(N_2+P_2+K_2) soil applic."N,P_2O_5,K_2O each at 4gm	0.18	0.20	0.19	0.13	0.14	0.14	0.12	0.15	0.14
L.S.D. . . . . at 5 % level	0.01	0.01	—	0.01	0.01	—	0.01	0.01	—
. . . . . at 1 % level	0.02	0.02	—	0.02	0.02	—	0.02	0.02	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used.

al.,(1982).

Concerning the effect of soil application with potassium sulphate, it is clear from the data obtained that K applied significantly increased leaf, stem and root-P content over the control in both Picual and Manzanillo olive rooted cuttings during the two seasons of study. These results are in agreement with those of Khamis et al. (1985) on five Citrus rootstock seedlings. On the other hand, regarding the effect of potassium sulphate fertilizer rate, data from the Tables (21 & 22) showed that rising the supply of K from (2.0 gm. to 4.0 gm. K_2O/rooted cutting) increased significantly leaf, stem and root-P content in Manzanillo, but with Picual cv. both K rates were the same during 1987 and 1988 seasons. Similar trend was reported by Domanskaya et al.,(1982).

As for the (N_2 + P_2) soil application treatment data revealed that it caused highly significant increases in leaf, stem and root-P content as compared with the control in both Picual and Manzanillo olive rooted cuttings during the study. This result confirmed past research by Khamis et al (1985) who found that foliar sprays with N + P foliar spray caused a significant increase in leaf-P content of 5 Citrus rootstock seedlings.

Furthermore, (N_2 + K_2) soil application treatment did not affect leaf, stem and root-P content in both Picual and Manzanillo olive rooted cuttings during the study. Moreover,

(N_2 + P_2 + K_2) soil application significantly increased leaf, stem and root-P content in both two olive rooted cuttings during the 1987 and 1988 seasons. Since, significance was at 1% level in both olive cvs. during the study. Similar results were obtained by Khamis et al.,(1985) on 5 Citrus rootstock seedlings and EL-Fangary,(1990) on Wshington navel orange and Valencia orange trees. Moreover, it is clear that phosphorus level in leaves was generally higher than those of stem and roots in both cvs. during the study.

Generally, it could be concluded that leaf, stem and root-P contents of both Picual and Manzanillo rooted cuttings were increased obviously by all soil application except foliar or soil application with $(NH_4)_2 SO_4$ and (N_2 + K_2). Moreover, rising the supply of P_2O_5 or K_2O from (2.0 gm to 4.0 gm /seedling) significantly increased leaf, stem and root P content while nitrogen application was conversly.

IV. 2.3. Potassium content :

IV. 2.3.a. Experiment, I :

Data concerning the effect of the different foliar spray treatments on the leaf, stem and root potassium percentage are presented in Tables (23 & 24). It is clear from the data obtained that, N-applied either as urea at 1% or $(NH_4)_2 SO_4$ at 1% foliar spray treatments significantly decreased leaf, stem and root-K content in both Picual and

Table (23): Potassium percentage in leaves, stem and roots of Picual rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1. Control "Water spray"	0.85	0.73	0.79	0.61	0.60	0.61	0.57	0.50	0.54
2. Urea 1 %	0.76	0.60	0.68	0.56	0.53	0.55	0.44	0.38	0.41
3. Ammonium sulphate 1%	0.56	0.60	0.58	0.53	0.42	0.48	0.51	0.42	0.47
4. Zinc sulphate 500 ppm	0.83	0.73	0.78	0.65	0.62	0.64	0.60	0.53	0.57
5. Gibberellin 100 ppm	0.91	0.79	0.85	0.75	0.68	0.72	0.64	0.69	0.67
6. Urea 1% + Zn SO_4 500 ppm	0.70	0.66	0.68	0.54	0.48	0.51	0.50	0.40	0.45
7. urea 1% + Gibberellin 100 ppm	0.71	0.62	0.67	0.52	0.51	0.52	0.53	0.44	0.49
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	0.58	0.60	0.59	0.53	0.54	0.54	0.43	0.38	0.41
9. $(NH_4)_2$ SO_4 1% + GA 100 ppm	0.70	0.70	0.70	0.55	0.53	0.54	0.45	0.40	0.43
L.S.D. . . . . at 5 % level	0.06	0.02	—	0.06	0.04	—	0.04	0.06	—
. . . . . at 1 % level	0.08	0.03	—	0.08	0.06	—	0.06	0.08	—

Table (24): Potassium percentage in leaves, stem and roots of Manzanillo rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1. Control "Water spray"	0.72	0.67	0.70	0.65	0.51	0.58	0.47	0.45	0.46
2. Urea 1 %	0.65	0.47	0.56	0.58	0.40	0.49	0.40	0.38	0.39
3. Ammonium sulphate 1%	0.62	0.52	0.57	0.49	0.38	0.44	0.36	0.37	0.37
4. Zinc sulphate 500 ppm	0.73	0.69	0.71	0.64	0.50	0.57	0.49	0.48	0.49
5. Gibberellin 100 ppm	0.84	0.75	0.80	0.71	0.59	0.65	0.63	0.53	0.58
6. Urea 1% + Zn SO_4 500 ppm	0.61	0.60	0.61	0.56	0.42	0.49	0.40	0.39	0.40
7. urea 1% + Gibberellin 100 ppm	0.61	0.43	0.52	0.53	0.33	0.43	0.41	0.37	0.39
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	0.57	0.48	0.53	0.50	0.38	0.44	0.40	0.38	0.39
9. $(NH_4)_2$ SO_4 1% + GA 100 ppm	0.63	0.46	0.55	0.48	0.38	0.43	0.33	0.35	0.34
L.S.D. . . . . at 5 % level	0.06	0.06	—	0.04	0.04	—	0.06	0.04	—
. . . . . at 1 % level	0.08	0.08	—	0.06	0.06	—	0.08	0.06	—

Manzanillo olive rooted cuttings as compared with control during the study. These results are in harmony with that reported by **Khamis** et al.,**(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings.

On the other hand, no definite trend could be achieved for potassium level in the different plant organs (leaf, stem and root) as affected by the N source from one compared with urea foliar spray treatment during the side and between both cultivars during two seasons of study from the other. Zn SO_4 at 500 ppm foliar spray treatment did not affect leaf, stem and root-K content as compared with the control in both olive cvs. during the study. These results were confirmed with the findings of **Labanuskas,(1968)** on Valencia orange leaves, and **Khadr** et al.,**(1978)** on Washington navel orange trees.

Moreover, gibberellin at 100 ppm foliar spray treatment significantly increased leaf, stem and root-K content in both two olive cvs. than the control during the study. These results are confirmed by the findings of **Khamis** et al.,**(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings. Applying Zn SO_4 combined either with urea or $(NH_4)_2$ SO_4 as foliar spray treatments caused highly significant decrease in leaf, stem and root-K content as compared with the control in both two olive cvs. during the study. Similar results were obtained by **EL- Shazly,(1980)** on Valencia orange trees. Nevertheless, it is quite clear from

Tables (23 & 24) that foliar spray either with (GA + urea) or (GA + $(NH_4)_2 SO_4$ treatments decreased significantly leaf, stem and root-K content in two olive cvs. below the control treatment during 1987 and 1988 seasons. These results are in disagreement with those of Khamis et al.,(1984) on Cleopatrea mandarin, sour orange and rough lemon seedlings.

Generally, it could be concluded that leaf, stem and root-K content of both Picual and Manzanillo olive seedlings was obviously decreased by all foliar spray treatments below the control. Furthermore, it is clear that leaf K level was higher than those of stem and roots in both olive cvs. during the two seasons of study. Since, stem K percentage was in between in this concern.

IV. 2.3.b. Experiment, II :

Concerning leaf, stem and root-K content as influeced by both application method and fertilizer rate as well as some N,P,K combinations, data are presented in Tables (25 & 26). It is clear from the data obtained that N applied either as foliar spray or soil application (2.0 gm. or 4.0 gm./seedling) significantly decreased leaf, stem and root- K content in both two olive cvs. during the two seasons of study. These results are in harmony with that reported by Iwasaki et al.,(1954) on sour orange and Satsuma mandarin, Kazak and Khalidy,(1976) on Avana mandarin trees, Khamis et al.,(1984) on Cleopatra mandarin, sour orange and rough

lemon and EL-Fangary,(1990) on Washington navel orange and Valencia orange trees.

On the other hand,the soil application with $(NH_4)_2 SO_4$ especially at the rate of 4.0 gm. N/rooted cutting decreased significantly the leaf, stem and root-K content as compared with foliar spray in both two olive cvs. seedlings during the study.

Concerning the effect of nitrogen fertilizer rate, data from Tables (25 & 26) showed that, rising the supply of N from (2.0 gm. to 4.0 gm./plant) decreased significantly by leaf, stem and root-K level except in Manzanillo seedling stem and root-K content was not affected during 1987 and 1988 seasons. These results are in confirmity with the findings of Reuther and Smith,(1950) and Reitz and Koo,(1960) on Valencia oranges, Saito and Yamamoto,(1962) on Poncirus trifoliata, Leyden,(1963) on grapefruit trees, EL-Naggar,(1964) on Washington navel orange trees, Smith,(1970) , EL-Kassas, (1972) , Embleton et al ., (1973) on Valencia orange, Reess and Koo,(1975) on orange leaves, Khalidy and Nayyal,(1976) on Eureka lemon and Hume et al.,(1985) on Valencia orange.

As for the superphosphate (P_1 or P_2) soil application treatments data in Tables (25 & 26) showed that P at the rate of (2.0 gm. - 4.0 gm. P_2O_5/rooted cutting) caused highly significant decrease in leaf, stem and root-K content below the control in both Picual and Manzanillo nursery plants during 1987 and 1988 seasons. Khamis et al., (1985)

Table (25): Potassium percentage in leaves, stem and roots of Picual rooted cuttings in relation to level , application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatment *	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "no fertilizer application"	0.85	0.73	0.79	0.61	0.60	0.61	0.57	0.50	0.54
2.N foliar applic."1% $(NH_4)_2 SO_4$"	0.56	0.60	0.58	0.53	0.42	0.48	0.51	0.42	0.47
3.N_1 soil applic. "2.0 gm N/plant"	0.60	0.60	0.60	0.47	0.54	0.51	0.53	0.41	0.47
4.N_2 soil applic. "4.0 gm N/plant"	0.46	0.46	0.46	0.47	0.37	0.42	0.45	0.36	0.41
5.P_1 soil applic. "2gm P_2O_5/plant"	0.55	0.56	0.56	0.53	0.46	0.50	0.48	0.43	0.46
6.P_2 soil applic. "4gm P_2O_5/plant"	0.58	0.58	0.58	0.56	0.46	0.51	0.51	0.44	0.48
7.K_1 soil applic. "2gm K_2O /plant"	0.99	0.88	0.94	0.70	0.72	0.71	0.63	0.63	0.63
8.K_2 soil applic. "4gm K_2O /plant"	1.00	0.92	0.96	0.75	0.71	0.73	0.63	0.59	0.61
9. (N_2 + P_2) soil applic."N, P_2O_5 each at 4.0 gm"	0.53	0.52	0.53	0.43	0.54	0.49	0.48	0.43	0.46
10.(N_2 + K_2) soil applic."N, K_2O each at 4.0 gm"	1.17	1.12	1.15	0.83	0.77	0.80	0.68	0.63	0.66
11.(N_2+P_2+K_2) soil applic"N,P_2O_5,K_2O each at 4 gm	1.20	1.05	1.13	0.79	0.73	0.76	0.67	0.59	0.63
L.S.D. . . . . at 5 % level	0.05	0.05	—	0.04	0.05	—	0.04	0.05	—
. . . . . at 1 % level	0.07	0.06	—	0.06	0.07	—	0.06	0.07	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used.

Table (26): Potassium percentage in leaves, stem and roots of Manzanillo rooted cuttings in relation to level , application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatment *	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "no fertilizer application"	0.72	0.67	0.70	0.65	0.51	0.58	0.47	0.45	0.46
2.N foliar applic."1% $(NH_4)_2 SO_4$"	0.62	0.52	0.57	0.49	0.38	0.44	0.36	0.37	0.37
3.N_1 soil applic. "2.0 gm N/plant"	0.51	0.48	0.50	0.38	0.34	0.36	0.33	0.36	0.35
4.N_2 soil applic. "4.0 gm N/plant"	0.45	0.41	0.43	0.32	0.30	0.31	0.27	0.30	0.29
5.P_1 soil applic. "2gm P_2O_5/plant"	0.56	0.49	0.53	0.42	0.36	0.39	0.40	0.38	0.39
6.P_2 soil applic. "4gm P_2O_5/plant"	0.57	0.48	0.53	0.44	0.42	0.43	0.38	0.40	0.39
7.K_1 soil applic. "2gm K_2O /plant"	1.25	1.17	1.21	0.88	0.73	0.81	0.59	0.58	0.59
8.K_2 soil applic. "4gm K_2O /plant"	1.33	1.24	1.29	0.98	0.77	0.88	0.63	0.59	0.61
9. (N_2+P_2) soil applic."N, P_2O_5 each at 4.0 gm."	0.53	0.52	0.53	0.42	0.41	0.42	0.40	0.40	0.40
10.(N_2+K_2) soil applic."N, K_2O each at 4.0 gm."	0.89	0.80	0.85	0.77	0.59	0.68	0.55	0.53	0.54
11.(N_2+P_2+K_2) soil applic."N,P_2O_5,K_2O each at 4gm	0.90	0.83	0.87	0.79	0.69	0.74	0.59	0.53	0.56
L.S.D. . . . . at 5 % level	0.05	0.05	—	0.04	0.04	—	0.05	0.05	—
. . . . . at 1 % level	0.07	0.07	—	0.06	0.06	—	0.07	0.07	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used.

reached the same conclusion on Cleopatra mandarin, Wellowleaf mandarin and rough lemon seedlings. On the contrary, Farid,(1979) on Mission olive seedlings concluded that the addition of phosphorus fertilizer either as soil or foliar applications had increased the total K content/ plant.

Regarding the effect of superphosphate soil fertilizer rate, data showed that rising the P supply from (2.0 gm. to 4.0 gm./ rooted cutting) did not statistically differ concerning K level in leaf, stem and root in both two olive cvs. during the study. In addition, the effect of soil application with potassium sulphate (K_1 or K_2), it is quite clear from the data obtained that K applied caused highly significant increase in leaf, stem and root- K content over the control in both Picual and Manzanillo olive rooted cuttings during 1987 and 1988 seasons. This result was previously confirmed by the findings of Page et al., (1963) on Citrus leaves, and Khamis et al.,(1985) on 5 Citrus rootstock seedlings.

On the other hand, the effect of potassium sulphate fertilizer rate i.e. (K_1 or K_2) data showed that rising the K supply from (2.0 gm. to 4.0 gm. K_2O/ plant) gave a marked increase in potassium %,especially leaves in both Picual and Manzanillo rooted cuttings during the two seasons of study.

(N_2+P_2) treatment decreased significantly leaf,stem and root-K content as compared with control treatment in both two olive cvs. rooted cuttings during the two seasons of

study. These results are in disagreement with that reported by EL-Fangary,(1990) on Washington navel orange and Valencia orange trees.

Moreover, (N_2 + K_2) and (N_2 + P_2 + K_2) treatments increased significantly leaf, stem and root-K content in both olive cvs. nursery plants over the control during the study. This result is similar to that reported by Jones et al.,(1973) and EL-Deeb,(1989) who noticed that (N + K) application increased significantly leaf-K content. Moreover, EL-Fangary,(1990) on Washington navel orange and Valencia orange cvs. found that foliar spray treatment with (N+P+K) caused highly significant increase in leaf K content over the control.

Generally, it could be concluded that leaf, stem and root-K content in rooted cuttings of both two olive cvs. was significantly decreased by soil application with (N) or (P) while (K) or (N_2+K_2) and (N_2 + P_2 + K_2) treatments increased leaf , stem and root-K content as compared with the control in both two olive cvs. during the study. In addition, K level in leaves was usually higher than those of stem and roots in both two olive cultivars during the study.

IV. 2.4. Calcium content :

IV. 2.4.a. Experiment, I :

Data concerning leaf, stem and root Ca content in both

Table (27): Calcium percentage in leaves, stem and roots of Picual rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1. Control "Water spray"	2.23	2.26	2.25	1.57	1.76	1.67	2.67	2.59	2.63
2. Urea 1 %	3.03	3.07	3.05	2.70	2.33	2.52	3.03	2.90	2.97
3. Ammonium sulphate 1%	2.47	2.76	2.62	2.47	2.17	2.32	2.80	2.67	2.74
4. Zinc sulphate 500 ppm	2.00	1.80	1.90	1.41	1.30	1.36	2.27	2.33	2.30
5. Gibberellin 100 ppm	2.57	2.83	2.70	2.36	2.63	2.50	3.03	3.06	3.05
6. Urea 1% + Zn SO_4 500 ppm	2.00	1.26	1.63	1.33	0.97	1.15	2.23	1.83	2.03
7. urea 1% + Gibberellin 100 ppm	2.37	2.90	2.64	2.20	2.26	2.23	2.93	2.87	2.90
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	1.60	1.80	1.70	1.43	1.23	1.33	1.10	2.31	1.71
9. $(NH_4)_2$ SO_4 1% + GA 100 ppm	2.49	2.63	2.56	1.93	2.06	2.00	3.06	2.77	2.92
L.S.D. . . . . at 5 % level	0.09	0.31	—	0.14	0.11	—	0.16	0.16	—
. . . . . at 1 % level	0.13	0.41	—	0.19	0.15	—	0.21	0.21	—

Table (28): Calcium percentage in leaves, stem and roots of Manzanillo rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Stray treatment	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "Water spray"	2.37	2.26	2.32	1.60	1.53	1.57	1.97	1.60	1.79
2.Urea 1 %	3.03	2.73	2.88	2.37	2.27	2.32	2.40	2.30	2.35
3.Ammonium sulphate 1%	3.13	2.83	2.98	1.90	1.87	1.89	2.20	2.11	2.16
4.Zinc sulphate 500 ppm	2.16	1.90	2.03	1.43	1.25	1.34	1.61	1.47	1.54
5.Gibberellin 100 ppm	2.40	2.37	2.39	1.67	1.57	1.62	2.06	1.97	2.02
6.Urea 1% + Zn SO_4 500 ppm	1.70	1.61	1.66	1.37	1.03	1.20	1.66	1.70	1.68
7.urea 1% + Gibberellin 100 ppm	2.78	2.93	2.86	1.87	2.53	2.20	2.16	2.53	2.35
8.$(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	2.13	2.00	2.07	1.40	1.29	1.35	1.67	1.43	1.55
9.$(NH_4)_2$ SO_4 1% + GA 100 ppm	2.63	2.37	2.50	1.85	1.99	1.92	2.65	2.67	2.66
L.S.D. . . . . at 5 % level	0.15	0.25	—	0.13	0.17	—	0.11	0.30	—
. . . . . at 1 % level	0.19	0.33	—	0.17	0.23	—	0.15	0.40	—

olive cvs. in response to the different foliar spray treatments are presented in Tables (27 & 28). It is clear from the data obtained that N foliar sprays either as urea at 1% or $(NH_4)_2 SO_4$ at 1% increased significantly leaf, stem and root Ca content in both two olive cvs. as compared with control treatment during the study. These results are in confirmity with the findings of Khamis et al.,(1984) on Cleopatra mandarin, sour orange and rough lemon seedlings. Moreover, $(NH_4)_2 SO_4$ at 1% foliar spray treatment showed a significant decrease in leaf, stem and root-Ca content in both Picual and Manzanillo cvs. as compared with urea foliar spray treatment except with leaf Ca% in Manzanillo cv. where both treatments were nearly the same.

Zinc sulphate at 500 ppm foliar spray treatment caused highly significant decrease in leaf, stem and root- Ca content below the control in both cvs. during the study. These results are in harmony with that reported by Labanauskas,(1968) and Asma,(1981) on Valencia orange trees and Khamis,(1984) on 5 Citrus rootstock seedlings.

Gibberellin at 100 ppm foliar spray treatment caused highly significant increase in leaf, stem and root-Ca content in Piual olive nursery plants while the difference was statistically negligible in Manzanillo olive plants as compared with control during the study.

Foliar spray with $ZnSO_4$ combined either with urea or $(NH_4)_2 SO_4$ significantly decreased leaf, stem and root-Ca

content as compared with the control in both two olive cvs. during 1987 and 1988 seasons. The same finding was obtained by EL-Shazly,(1980) on Valencia orange trees.

It is quite clear from Tables (27 & 28) that (urea or $(NH_4)_2 SO_4$ + GA_3) foliar spray treatment significantly increased leaf, stem and root-Ca content over the control in Picual and Manzanillo rooted cuttings during the study. These results were confirmed by the findings of Abd-EL-Latif,(1980) on Washington navel orange trees and Khamis et al.,(1984) on Cleopatrea mandarin, sour orange and rough lemon seedlings.

Generally, it could be concluded that leaf, stem and root-Ca content of both Picual and Manzanillo nursery olive plants was decreased obviously by foliar spray with $ZnSO_4$ and their combinations either with urea or $(NH_4)_2 SO_4$ while all the other treatments increased significantly Ca-content.

IV. 2.4.b. Experiment, II :

Concerning leaf, stem and root-Ca content as influenced by application method and fertilizer rate, as well as some combinations of N,P,K fertilizers, data are presented in Tables (29 & 30). It is clear from the data obtained that N application either as foliar spray or soil adding (2.0 gm or 4.0 gm actual N/plant) increased significantly the leaf, stem and root Ca-content in both two olive cvs. during 1987

and 1988 seasons. These results are in harmony with that reported by **Khamis et al.,(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings and **EL-Fangary,(1990)** on Washington navel orange and Valencia orange trees.

With respect to leaf, stem and root-Ca content as influenced by application method outlined data showed that both leaves and stem were not responded in general. Since the $(NH_4)_2 SO_4$ soil application either at (2.0 gm or 4.0 gm actual N per plant) increased significantly the Ca % in roots, as well as stem Ca level in few cases as compared with foliar spray in both two olive cvs. during the study.

Concerning the effect of N-fertilizer rate data in **Tables (29 & 30)** showed that increasing the supply of N from (2.0 gm to 4.0 gm N/plant) did not affect Ca level in leaves. While in both stem and root-Ca contents were slightly affected in both two olive cvs. during the study. However, the increase in rate of N fertilizer was associated with increasing the Ca stem level, but the reverse was true with root. These results are in confirmity with the findings of **EL-Kassas,(1972)** on Valencia orange trees and **Khalidy and Nayyal,(1976)** on Eureka lemon.

As for the effect of superphosphate (P_1 or P_2) soil application treatments data in **Tables (29 & 30)** showed that leaf, stem and root-Ca content in P applied olive plants were significantly increased over the control during 1987 and 1988 seasons, regardless of cultivar and the P rate. The

Table (29): Calcium percentage in leaves, stem and roots of Picual rooted cuttings in relation to level , application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatment *	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "no fertilizer application"	2.23	2.26	2.25	1.57	1.76	1.67	2.67	2.59	2.63
2.N foliar applic. "1% $(NH_4)_2 SO_4$"	2.47	2.76	2.62	2.47	2.17	2.32	2.80	2.67	2.74
3.N_1 soil applic. "2.0 gm N/plant"	2.49	2.90	2.70	2.07	2.53	2.30	3.70	4.13	3.92
4.N_2 soil applic. "4.0 gm N/plant"	2.50	2.89	2.70	2.63	2.60	2.62	3.25	3.83	3.54
5.P_1 soil applic. "2gm P_2O_5/plant"	2.60	2.76	2.70	2.10	2.13	2.11	3.33	3.80	3.56
6.P_2 soil applic. "4gm P_2O_5/plant"	2.67	2.81	2.74	1.97	2.16	2.06	3.15	3.98	3.57
7.K_1 soil applic. "2gm K_2O /plant"	1.90	1.73	1.82	1.20	1.40	1.30	1.93	1.78	1.86
8.K_2 soil applic. "4gm K_2O /plant"	1.85	1.70	1.78	1.17	1.23	1.20	1.85	1.70	1.78
9. (N_2+P_2) soil applic."N, P_2O_5 each at 4.0 gm."	2.53	2.76	2.60	1.93	2.33	2.13	3.11	2.99	3.05
10.(N_2+K_2) soil applic."N, K_2O each at 4.0 gm."	2.53	2.75	2.64	3.07	2.47	2.77	3.23	3.23	3.23
11.(N_2+P_2+K_2) soil applic."N,P_2O_5,K_2O each at 4gm	2.88	3.13	3.00	2.30	2.70	2.50	3.93	3.30	3.62
L.S.D. . . . . at 5 % level	0.24	0.49	—	0.35	0.34	—	0.43	0.38	—
. . . . . at 1 % level	0.33	0.67	—	0.48	0.46	—	0.58	0.52	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used.

Table (30): Calcium percentage in leaves,stem and roots of Manzanillo rooted cuttings in relation to level , application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatment *	% on the dry matter basis								
	Leaves			Stem			Roots		
	1987	1988	aver	1987	1988	aver	1987	1988	aver
1.Control "no fertilizer application"	2.37	2.26	2.32	1.60	1.53	1.57	1.97	1.60	1.79
2.N foliar applic. "1% $(NH_4)_2 SO_4$"	3.13	2.83	2.98	1.90	1.78	1.84	2.20	2.11	2.16
3.N_1 soil applic. "2.0 gm N/plant"	2.93	2.80	2.87	1.99	2.17	2.08	3.53	3.33	3.43
4.N_2 soil applic. "4.0 gm N/plant"	2.93	2.83	2.88	2.10	2.33	2.22	3.33	2.36	3.35
5.P_1 soil applic. "2gm P_2O_5/plant"	2.97	2.85	2.91	2.11	2.10	2.10	2.56	2.63	2.60
6.P_2 soil applic. "4gm P_2O_5/plant"	3.27	3.41	3.34	2.43	2.17	2.30	2.80	2.63	2.72
7.K_1 soil applic. "2gm K_2O /plant"	1.88	1.71	1.79	1.23	1.10	1.17	1.33	1.31	1.32
8.K_2 soil applic. "4gm K_2O /plant"	1.79	1.91	1.85	1.30	1.11	1.21	1.38	1.21	1.30
9. (N_2+P_2) soil applic. "N, P_2O_5 each at 4.0 gm."	3.00	2.90	2.95	2.23	2.30	2.27	3.10	3.17	3.14
10.(N_2+K_2) soil applic. "N, K_2O each at 4.0 gm."	2.97	3.07	3.02	2.40	2.60	2.50	3.83	3.53	3.68
11.(N_2+P_2+K_2) soil applic."N,P_2O_5,K_2O each at 4gm	3.15	2.89	3.02	2.33	2.27	2.30	2.83	3.27	3.05
L.S.D. . . . . at 5 % level	0.30	0.34	—	0.30	0.34	—	0.59	0.45	—
. . . . . at 1 % level	0.40	0.46	—	0.40	0.47	—	0.81	0.62	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N,P,K fertilizers used.

same finding was found by **Farid,(1979)** on Mission olive seedlings.

Regarding the effect of superphosphate soil fertilizer rate, data showed that rising the dose from 2.0 gm to 4.0 gm P_2O_5/plant did not statistically affect the Ca level in all the olive plant organs with both cultivars.

In addition, concerning the effect of soil application with potassium sulphate (K_1 or K_2), it is quite clear from the data obtained that K application caused significantly an obvious decrease in leaf, stem and root-Ca content below the control in both Picual and Manzanillo rooted cuttings during 1987 and 1988 seasons. These results were confirmed by the findings of **Holevas,(1976)** on olive plants, and **Khamis** et al.,(1984) on 5 Citrus rootstock seedlings.

On the other hand, regarding the effect of potassium sulphate fertilizer rate (K_1 / K_2) data showed that rising the supply of K_2O from (2.0 gm to 4.0 gm/ plant) did not affect leaf, stem and root-Ca content in both two olive cvs. during the study.

With respect to (N_2+P_2),(N_2+K_2) and (N_2+P_2+K_2) soil application treatments data obtained showed that any of these treatments significantly increased leaf, stem and root-Ca content as compared with control treatment in both Picual and Manzanillo olive cultivars during the study. The same finding was obtained by **EL-Fangary,(1990)** on Washington

same finding was found by **Farid,(1979)** on Mission olive seedlings.

Regarding the effect of superphosphate soil fertilizer rate, data showed that rising the dose from 2.0 gm to 4.0 gm P_2O_5/plant did not statistically affect the Ca level in all the olive plant organs with both cultivars.

In addition, concerning the effect of soil application with potassium sulphate (K_1 or K_2), it is quite clear from the data obtained that K application caused significantly an obvious decrease in leaf, stem and root-Ca content below the control in both Picual and Manzanillo rooted cuttings during 1987 and 1988 seasons. These results were confirmed by the findings of **Holevas,(1976)** on olive plants, and **Khamis** *et al.*,(1984) on 5 Citrus rootstock seedlings.

On the other hand, regarding the effect of potassium sulphate fertilizer rate (K_1 / K_2) data showed that rising the supply of K_2O from (2.0 gm to 4.0 gm/ plant) did not affect leaf, stem and root-Ca content in both two olive cvs. during the study.

With respect to (N_2+P_2),(N_2+K_2) and (N_2+P_2+K_2) soil application treatments data obtained showed that any of these treatments significantly increased leaf, stem and root-Ca content as compared with control treatment in both Picual and Manzanillo olive cultivars during the study. The same finding was obtained by **EL-Fangary,(1990)** on Washington

navel orange and Valencia orange trees.

Generally, it could be concluded that leaf, stem and root-Ca % of both two olive cvs. was significantly increased by soil application with (N), (P), (N_2+P_2),(N_2+K_2) and (N_2+P_2+K_2) treatments while the opposite was true with both treatments of potassium application when it was added solely.

IV. 2.5. Magnesium content :

IV. 2.5.a. Experiment, I :-

Data concerning leaf magnesium content in response to the different used foliar treatments are presented in Table (31). It is evident that, leaf-Mg content in both Picual and Manzanillo olive cultivars had been significantly increased in the sprayed nursery plants as compared with the control. N foliar sprays either with urea or $(NH_4)_2 SO_4$ each at 1% concentration increased significantly leaf-Mg content over the control in the two cvs. during the study. The same trend was reported by Milella and Deidda, (1976) on Avana mandarin trees and Khamis et al.,(1984) on Cleopatra mandarin, sour orange and rough lemon seedlings.

On the other hand, both N sources was not differed significantly in this concern during both seasons of study, regardless of olive cultivars.

On the other hand , $ZnSO_4$ at 500 ppm foliar spray treatment caused highly significant increase in leaf-Mg content for both two olive cvs. rooted cutting during the study. On the contrary, **Labanauskas, (1968)** on Valencia orange and **Khamis,(1984)** on 5 Citrus rootstock seedlings all suggested that zinc application showed a significant decrease in leaf-Mg content.

Gibberellin at 100 ppm foliar spray treatment increased significantly leaf-Mg content in both two olive cvs. during the two seasons of study. This result is in agreement with that mentioned by **Khamis** *et al.*,**(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings.

Furthermore, foliar sprays with zinc sulphate combined with urea/$(NH_4)_2SO_4$ solutions caused highly significant increase in leaf-Mg content as compared with the control in both olive cvs. during 1987 and 1988 seasons. This result is in disagreement with the findings of **EL-Gazzar,(1986)** and **Shawky** *et al.*,**(1986)** on Washington navel orange trees. In addition, (GA_3 + urea/$(NH_4)_2SO_4$) foliar spray treatments significantly increased leaf-Mg content over the control in both Picual and Manzanillo olive rooted cuttings during the study. The same finding were obtained by Khamis *et al.*, **(1984)** on Cleopatra mandarin, sour orange and rough lemon seedlings.

Generally, it could be concluded that leaf-Mg content of both Picual and Manzanillo olive rooted cuttings was in-

creased obviously by all foliar spray treatments over control during the two seasons of study.

IV. 2.5.b. Experiment, II :

Concerning leaf-Mg content as influenced by both application method and fertilizer rate, as well as some combinations of N,P,K fertilizers, data are presented in Table (32). It is clear from the data obtained that leaf Mg % was significantly increased when $(NH_4)_2 SO_4$ was applied either as foliar spray at 1% concentration or soil application at the rate of (2.0 gm/ 4.0 gm actual N/rooted cutting) as compared with control in both two olive cvs. during the study. These results confirmed past researchs of Milella and Deidda,(1976) in Avana mandarin trees and Khamis et al., (1984) on Cleopatra mandarin, sour orange and rough lemon seedlings.

With respect to leaf-Mg content as influenced by application method of $(NH_4)_2 SO_4$, data showed that, the soil application either at the rate of 2.0 gm or 4.0 gm N/rooted cutting caused highly significant increase in leaf-Mg content than those of the foliar spray treatment except in 1988 season with the N_1 rate in both two olive cvs. during the study. These results are in confirmity with the findings of Badade,(1966).

In addition, data from Table (32) showed that, rising

Table (31): Magnessium percentage in leaves of Manzanillo and Picual rooted cuttings as affected by foliar spray with 2 N sources, Zn and gibberellin during 1987 and 1988 seasons.

Spray treatments	% on the dry atter basis					
	Manzanillo			Picual		
	Leaves			Leaves		
	1987	1988	aver	987	1988	aver
1. Control "Water spray"	0.19	0.15	0.17	0.18	0.17	0.18
2. Urea 1 %	0.24	0.23	0.24	0.22	0.24	0.23
3. Ammonium sulphate 1%	0.26	0.24	0.25	0.21	0.23	0.22
4. Zinc sulphate 500 ppm	0.23	0.23	0.23	0.20	0.23	0.22
5. Gibberellin 100 ppm	0.24	0.24	0.24	0.21	0.22	0.22
6. Urea 1% + Zn SO_4 500 ppm	0.24	0.23	0.24	0.22	0.22	0.22
7. urea 1% + Gibberellin 100 ppm	0.30	0.23	0.27	0.22	0.23	0.23
8. $(NH_4)_2$ SO_4 1% + Zn SO_4 500 ppm	0.28	0.22	0.25	0.23	0.23	0.23
9. $(NH_4)_2$ SO_4 1% + GA 100 ppm	0.22	0.24	0.23	0.23	0.23	0.23
L.S.D. . . . . at 5 % level	0.03	0.02	—	0.02	0.01	——
. . . . . at 1 % level	0.04	0.03	—	0.03	0.02	——

Table (32): Magnessium percentage in leaves of Manzanillo and Picual rooted cuttings in relation to level, application method and some combinations of N,P,K fertilizers during 1987 and 1988 seasons.

Treatments *	% on the dry matter basis					
	Manzanillo			Picual		
	Leaves			Leaves		
	1987	1988	aver	1987	1988	aver
1.Control "no fertilizer application"	0.19	0.15	0.17	0.18	0.17	0.18
2.N foliar applic. "1% $(NH_4)_2 SO_4$"	0.27	0.23	0.25	0.21	0.23	0.22
3.N_1 soil applic. "2.0 gm N/plant"	0.30	0.20	0.25	0.25	0.23	0.24
4.N_2 soil applic. "4.0 gm N/plant"	0.31	0.29	0.30	0.27	0.30	0.29
5.P_1 soil applic. "2gm P_2O_5/plant"	0.27	0.24	0.26	0.24	0.21	0.24
6.P_2 soil applic. "4gm P_2O_5/plant"	0.31	0.29	0.30	0.25	0.23	0.24
7.K_1 soil applic. "2gm K_2O /plant"	0.28	0.23	0.26	0.23	0.23	0.23
8.K_2 soil applic. "4gm K_2O /plant"	0.30	0.24	0.27	0.24	0.24	0.24
9. (N_2 + P_2) soil applic."N, P_2O_5 each at 4.0 gm	0.25	0.26	0.26	0.24	0.27	0.26
10.(N_2 + K_2) soil applic."N, K_2O each at 4.0 gm	0.27	0.29	0.28	0.24	0.27	0.26
11.(N_2+P_2+K_2) soil applic."N, P_2O_5, K_2O each at 4gm	0.26	0.24	0.25	0.24	0.26	0.25
L.S.D. . . . . at 5 % level	0.01	0.05	—	0.01	0.01	—
. . . . . at 1 % level	0.02	0.07	—	0.02	0.02	—

* Ammonium sulphate, superphosphate and potassium sulphate were the N, P, K fertilizers used.

the supply of $(NH_4)_2 SO_4$ from (2.0 gm to 4.0 gm N/ rooted cutting) increased significantly leaf-Mg content in both Picual and Manzanillo olive rooted cuttings during 1987 and 1988 seasons. These results are in harmony with that reported by **Reuther and smith,(1950)** on Valencia orange trees and **Khalidy and Nayyal,(1976)** on Eureka lemon trees.

As for superphosphate (P_1 or P_2) soil application treatments, data showed that, both rates of superphosphate caused highly significant increase in leaf - Mg content over the control in both two olive cvs. during the study. This result is similar to that achieved by **Farid,(1979)** on Mission olive seedlings.

Moreover, concerning the effect of fertilizer rate,data showed that, rising the supply of P_2O_5 from (2.0 gm to 4.0 gm/rooted cutting) significantly increased leaf-Mg content during the study.

Regarding the effect of soil application with potassium sulphate (K_1 or K_2) treatments, it is evident from the results obtained that leaf-Mg content was significantly increased over the control in both Picual and Manzanillo rooted cuttings during the study. In this respect , **Khamis et al.,(1985)** found that leaf-Mg content was slightly decreased after spraying 5 Citrus rootstock seedlings with potassium sulphate at 300 ppm.

Moreover, regarding the effect of K fertilizer rate,

data showed that, rising the supply of K from (2.0 gm to 4.0 gm K_2O/rooted duttings) significantly increased leaf-Mg content in both two olive cvs. during the study.

(N_2 + P_2) soil application treatment caused significant increase in leaf-Mg content over control treatment in both two olive cvs during the two seasons of study. These results are in agreement with that reported by **EL-Fangary,(1990)** on both Washington navel orange and Valencia orange trees.

Moreover, both combinations of (N_2 + K_2) and (N_2+P_2+K_2) soil application treatments caused highly significant increase in leaf- Mg content over the control during the study. These results is similar to that reported by **Khamis et al.,(1985)** on some Citrus seedlings.

Generally, it could be concluded that leaf - Mg content of both Picual and Manzanillo rooted cuttings was increased obviously by all treatments applied in the second experiment.

Moreover, rising the supply of any of N,P,K fertilizers increased significantly leaf-Mg content.

In addition, N soil application especially at the rate of 4.0 gm N/plant was more effective in increasing the leaf Mg % as compared to the foliar spray treatment.

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